Fig. 1A

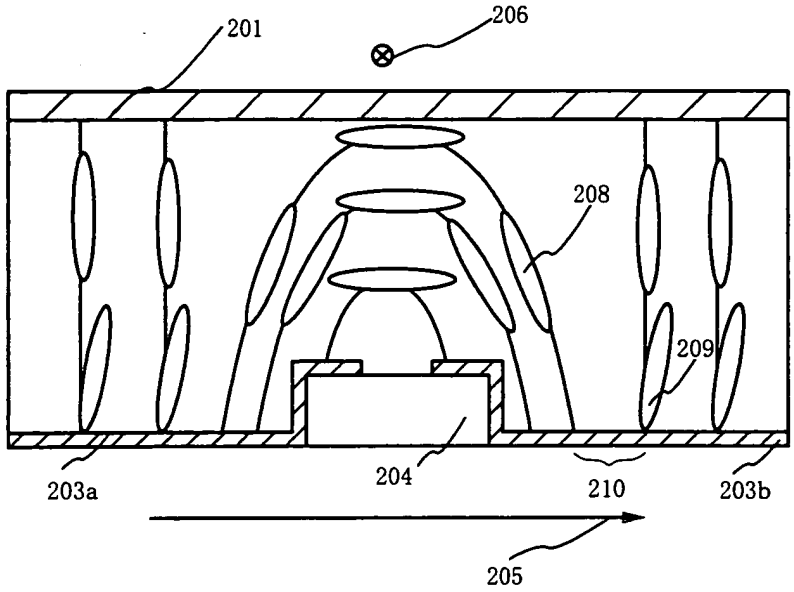


Fig. 1B

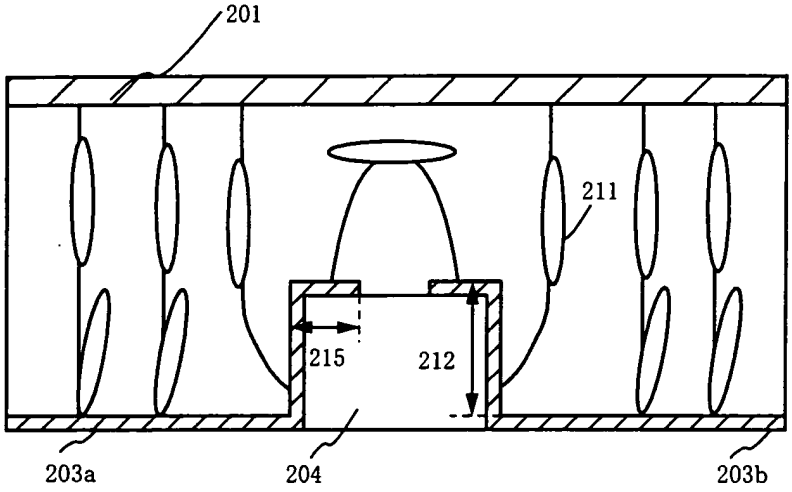
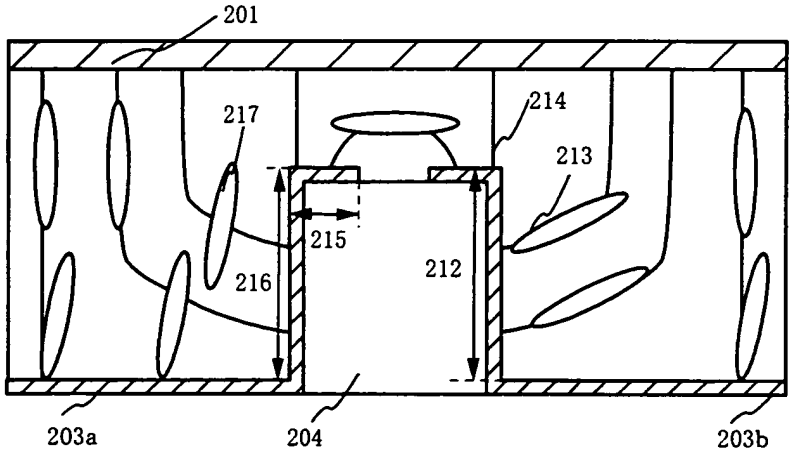
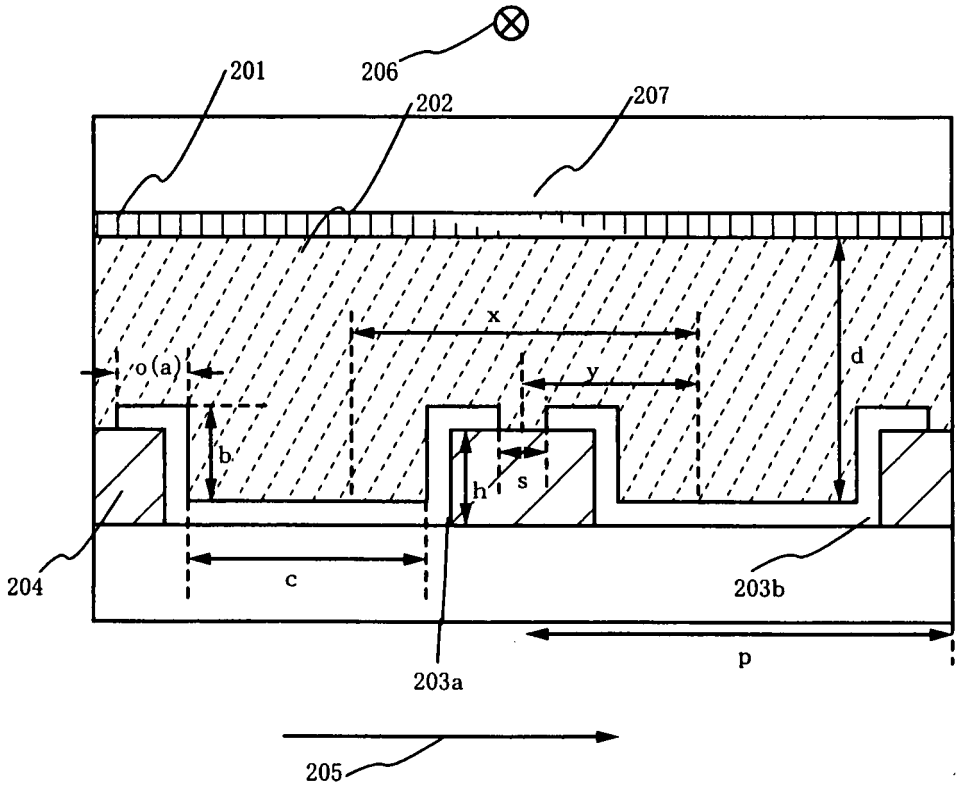


Fig. 1C





a: first region of the pixel electrodee
b: second region of the pixel electrode
c: third region of the pixel electrode

o: width of the first region of the pixel electrode
d: cell gap
p: pixel pitch
s: distance between pixel electrodes
h: height of convex portion
x, y: widths of light leakage and disclination

Fig. 2

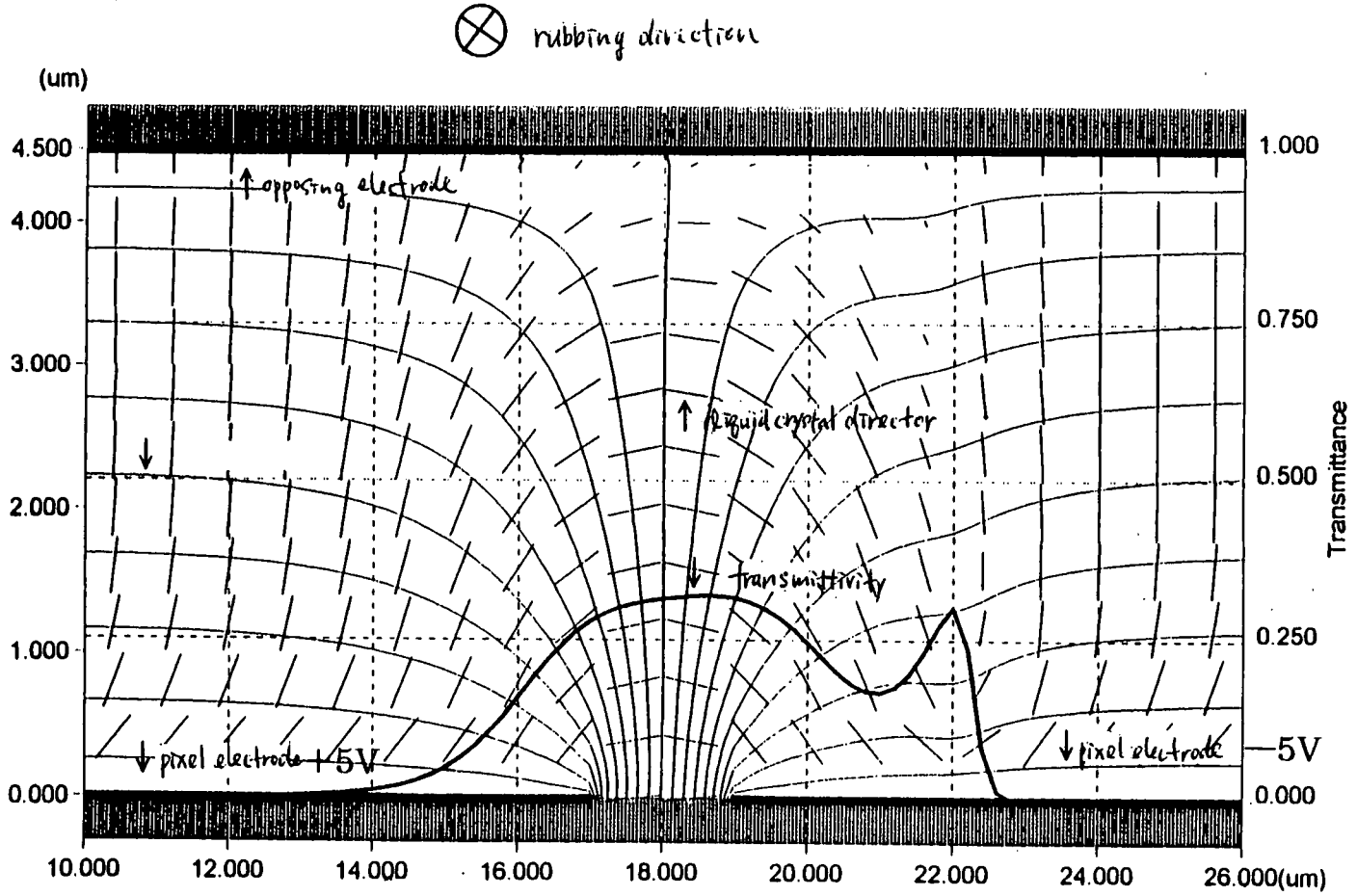

rubbing direction
(um)
4.500
4.000
3.000
2.000
1.000
0.000
opposing electrode
liquid crystal director
transmittivity
pixel electrode +5V
pixel electrode
—5V
1.000
0.750
0.500
0.250
0.000
Transmittance
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
26.000(um)
rubbing direction
non convex portion
distance between pixel electrodes : 2.0 μm

Fig. 3

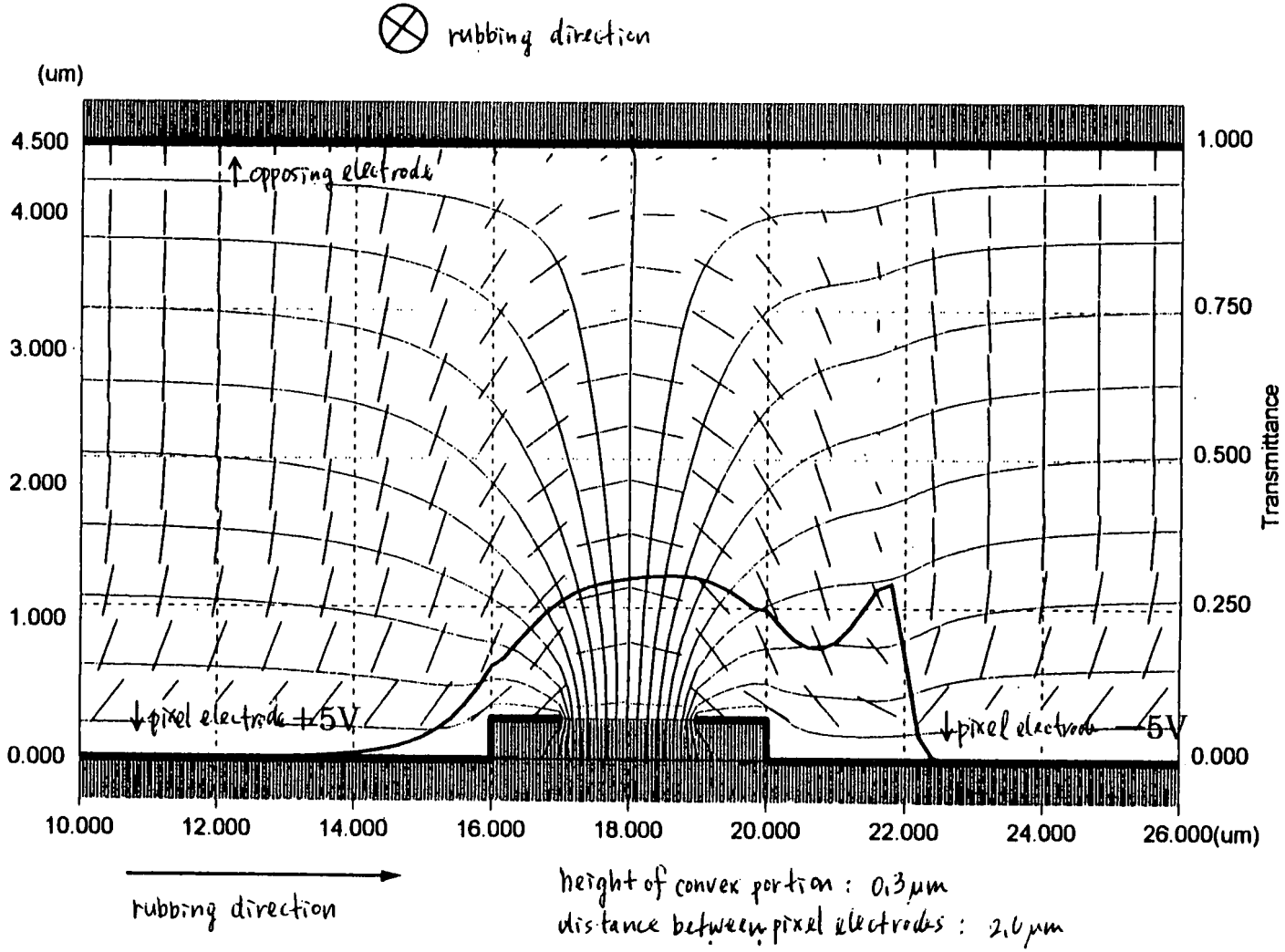

⊗ rubbing direction
(um)
4.500
4.000
3.000
2.000
1.000
0.000
opposing electrode
pixel electrode +5V
pixel electrode −5V
1.000
0.750
0.500
0.250
0.000
Transmittance
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
26.000(um)
rubbing direction
height of convex portion : 0.3μm
distance between pixel electrodes : 2.6μm

Fig. 4

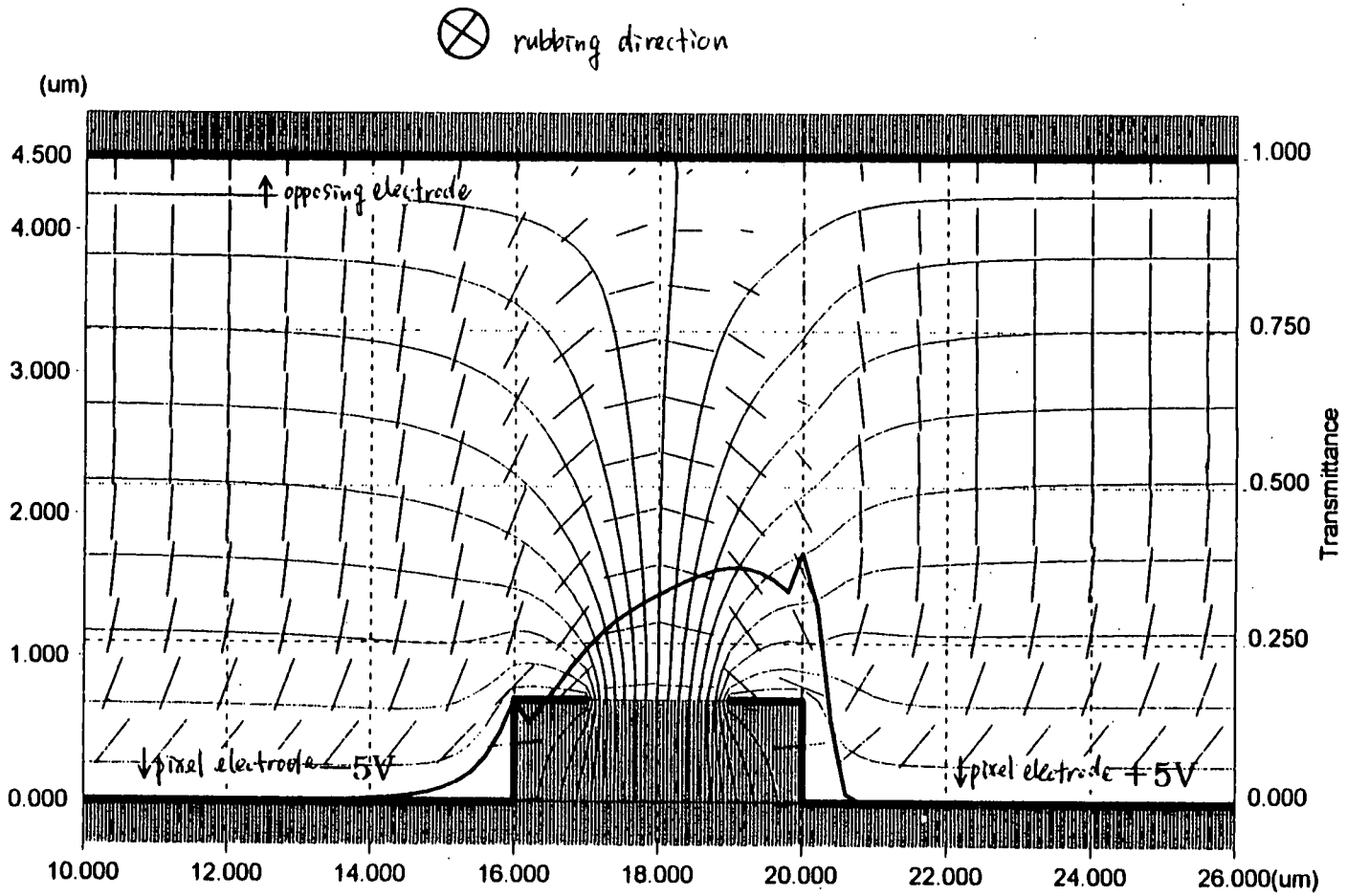

⊗ rubbing direction
(um)
4.500
4.000
3.000
2.000
1.000
0.000
opposing electrode
pixel electrode −5V
pixel electrode +5V
1.000
0.750
0.500
0.250
0.000
Transmittance
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
26.000(um)
rubbing direction
height of convex portion : 0.7 μm
distance between pixel electrodes : 2.0 μm

Fig. 5

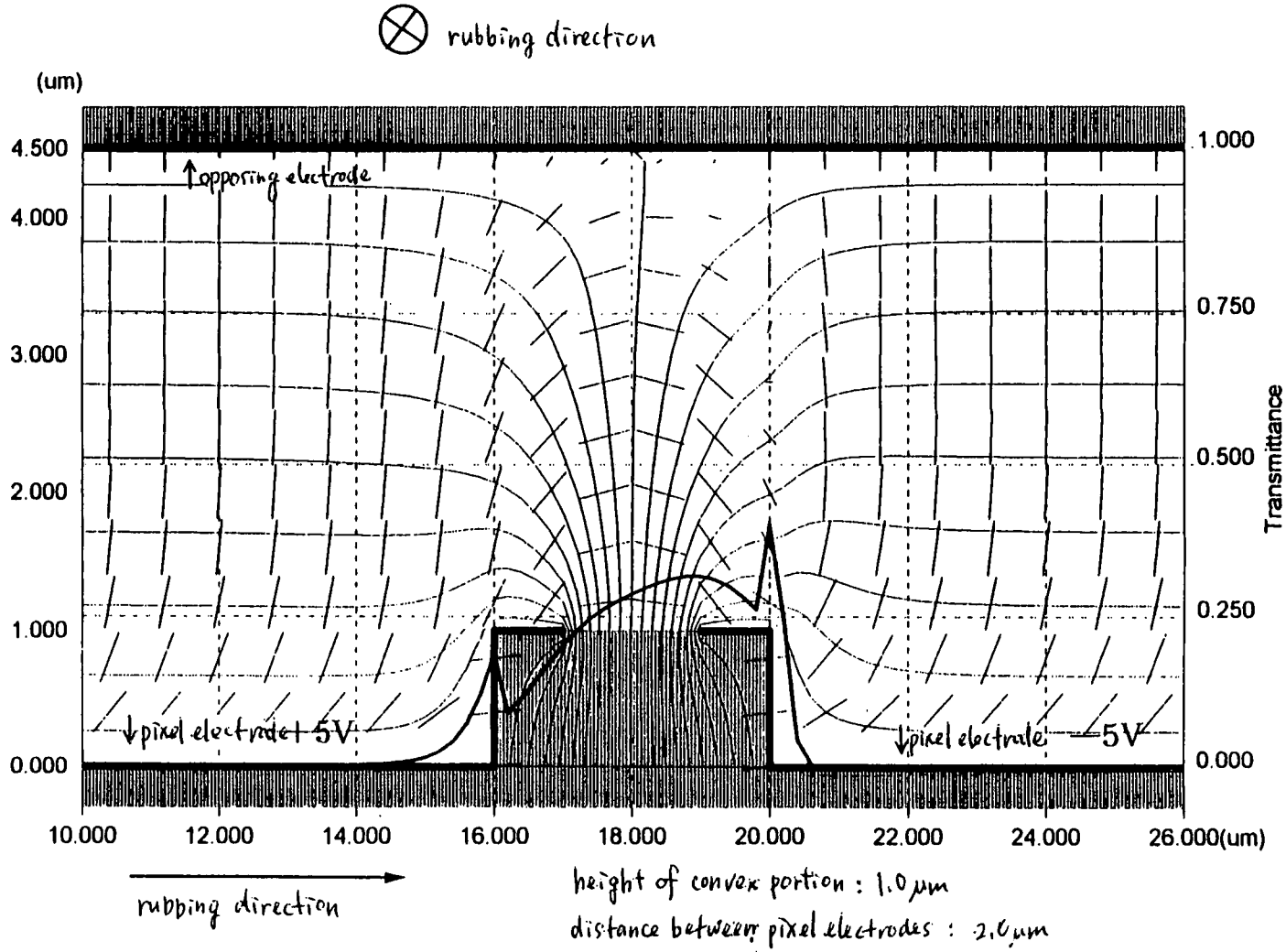

rubbing direction
(um)
4.500
4.000
3.000
2.000
1.000
0.000
opposing electrode
pixel electrode +5V
pixel electrode -5V
1.000
0.750
0.500
0.250
0.000
Transmittance
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
26.000(um)
rubbing direction
height of convex portion : 1.0 μm
distance between pixel electrodes : 2.0 μm

Fig. 6

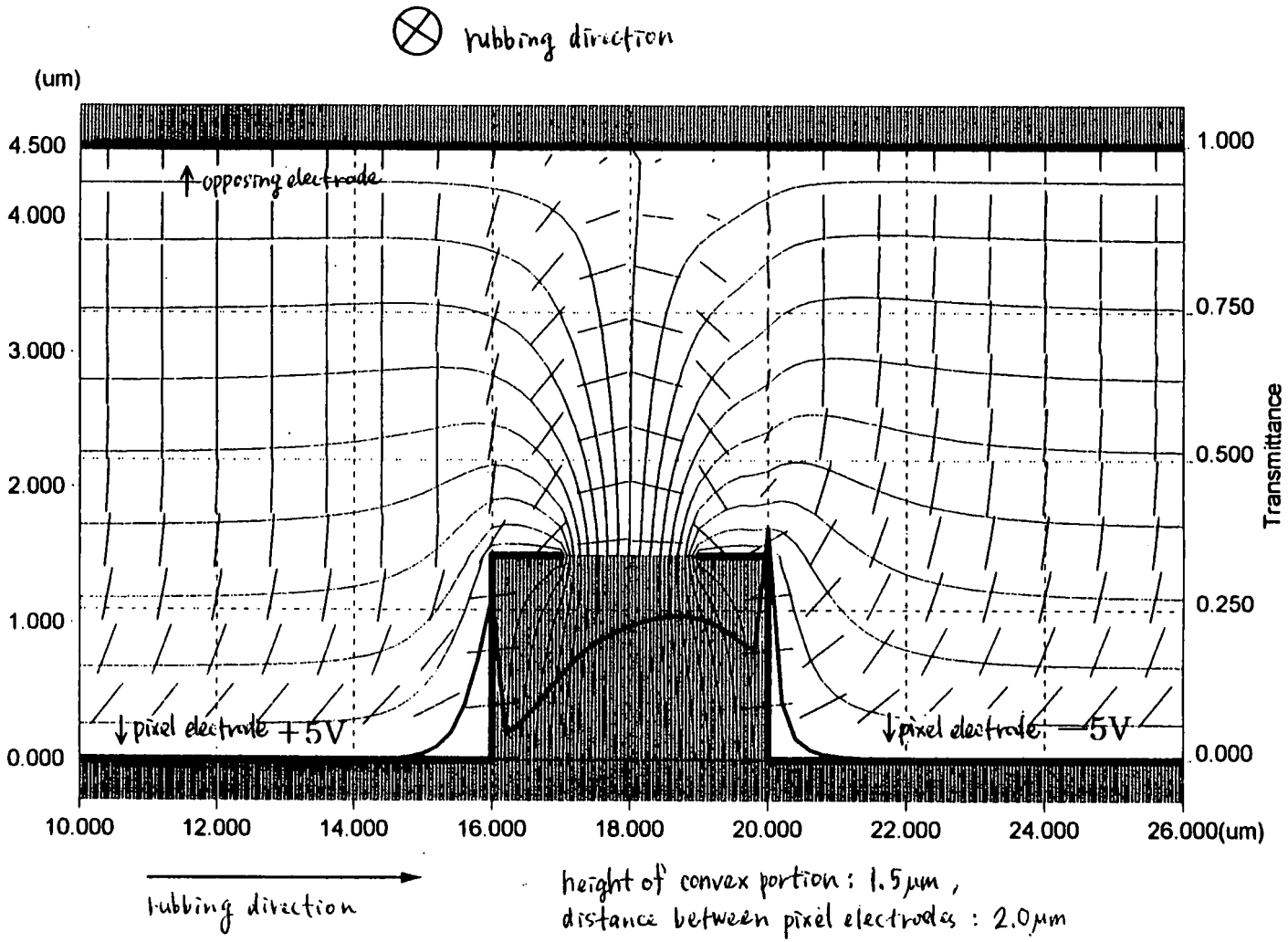

rubbing direction
(um)
4.500
4.000
3.000
2.000
1.000
0.000
opposing electrode
pixel electrode +5V
pixel electrode −5V
1.000
0.750
0.500
0.250
0.000
Transmittance
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
26.000(um)
rubbing direction
height of convex portion : 1.5μm ,
distance between pixel electrodes : 2.0μm

Fig. 7

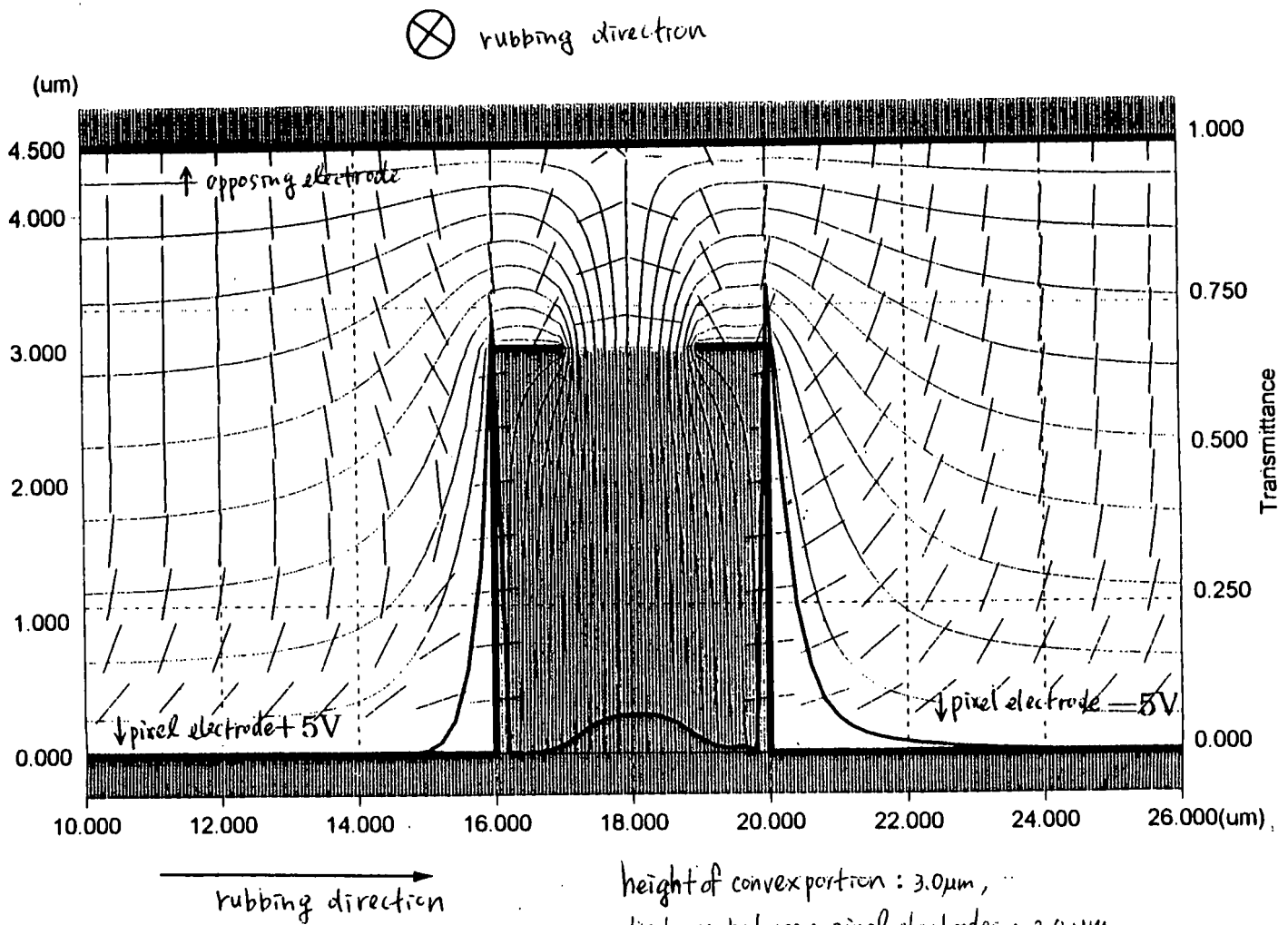
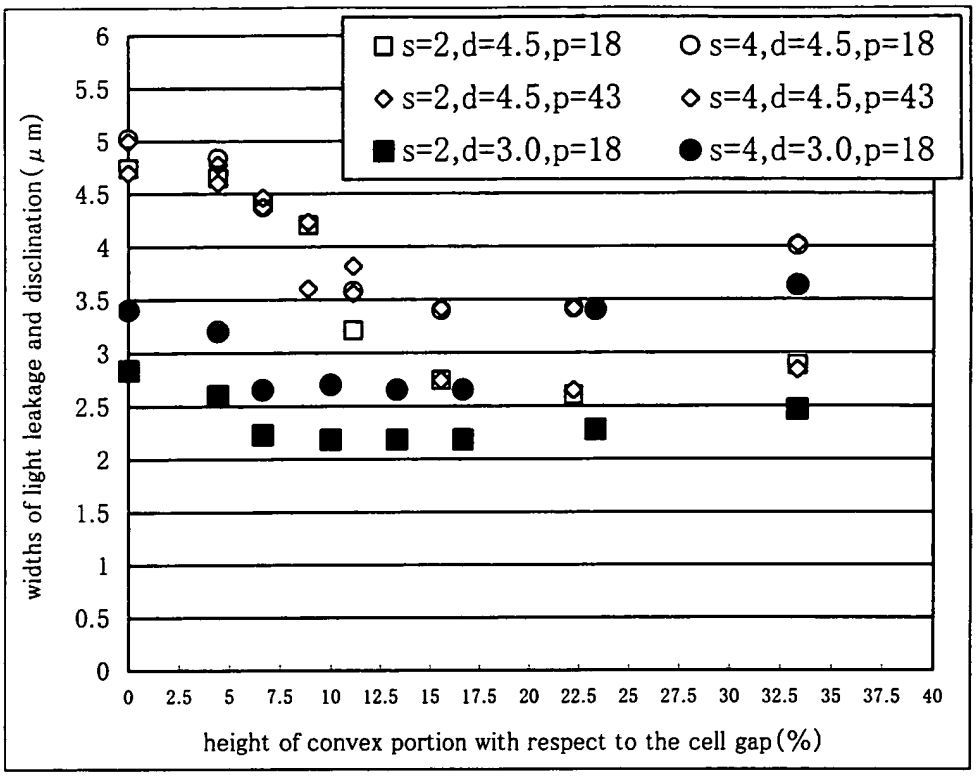

rubbing direction
(um)
4.500
4.000
3.000
2.000
1.000
0.000
opposing electrode
pixel electrode +5V
pixel electrode −5V
1.000
0.750
0.500
0.250
0.000
Transmittance
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
26.000(um)
rubbing direction
height of convex portion : 3.0μm,
distance between pixel electrodes : 2.0μm

Fig. 8

Fig. 9



d: cell gap (μm)
s: distance between pixel electrodes (μm)
p: pixel pitch (μm)

relationship between widths of light leakage and disclination (x) and height of convex portion (h)

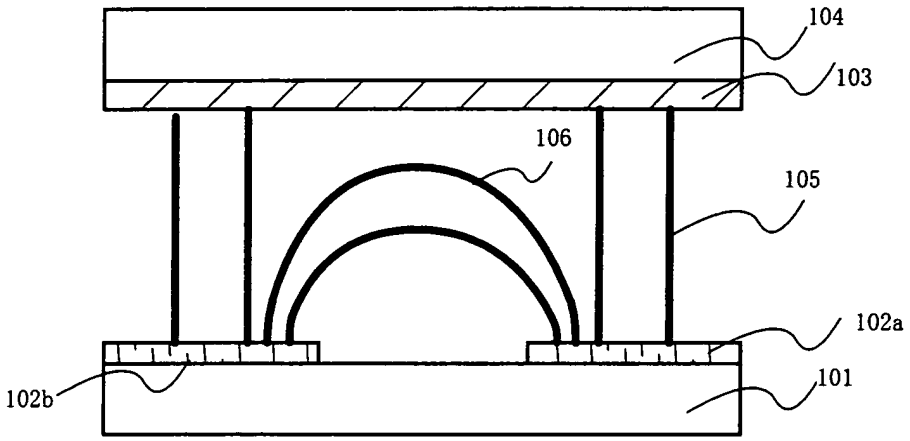


Fig. 10

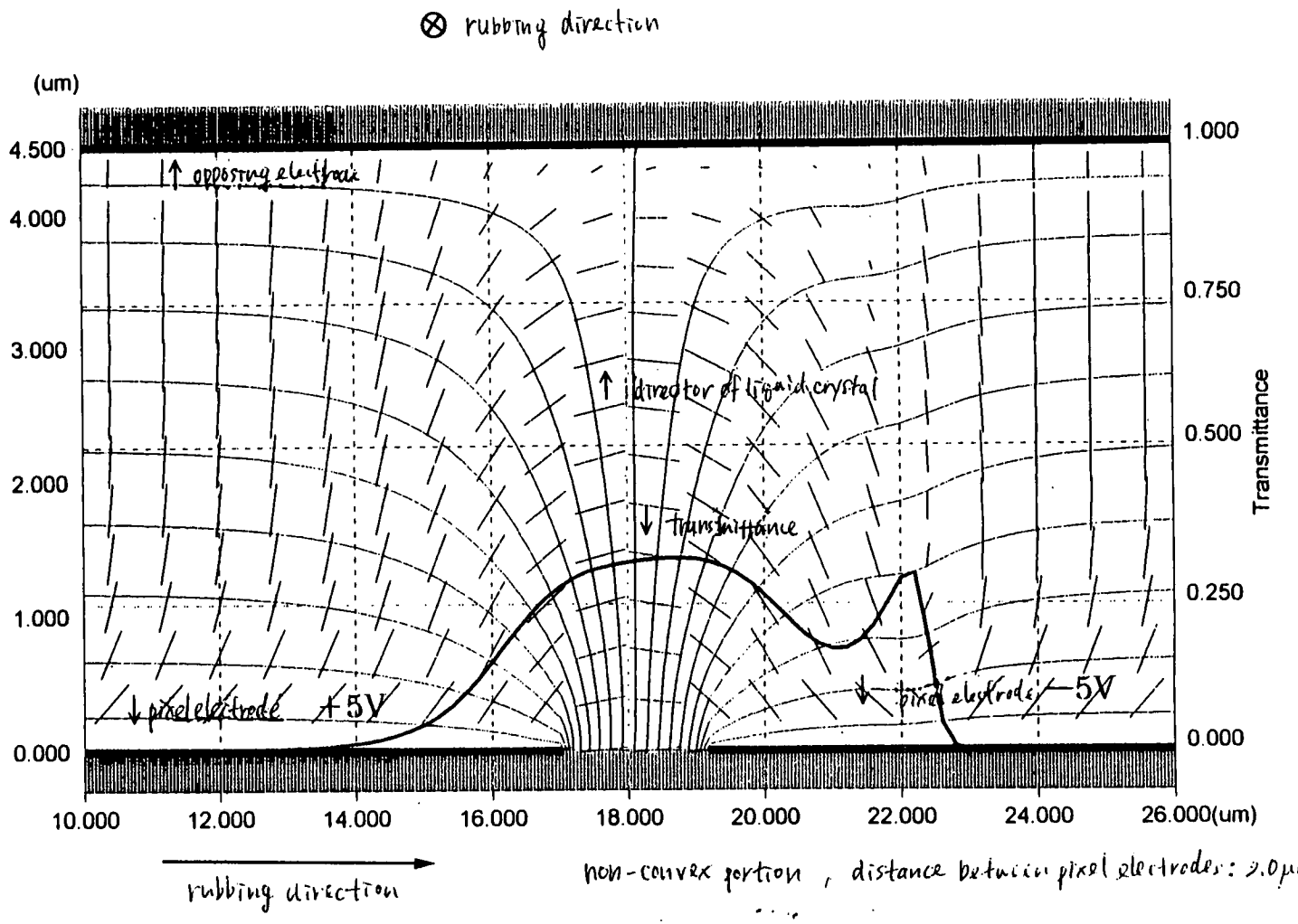

⊗ rubbing direction
(um)
4.500
4.000
3.000
2.000
1.000
0.000
opposing electrode
director of liquid crystal
transmittance
pixel electrode +5V
pixel electrode −5V
1.000
0.750
0.500
0.250
0.000
Transmittance
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
26.000(um)
rubbing direction
non-convex portion , distance between pixel electrodes: 2.0μm

Fig. 11

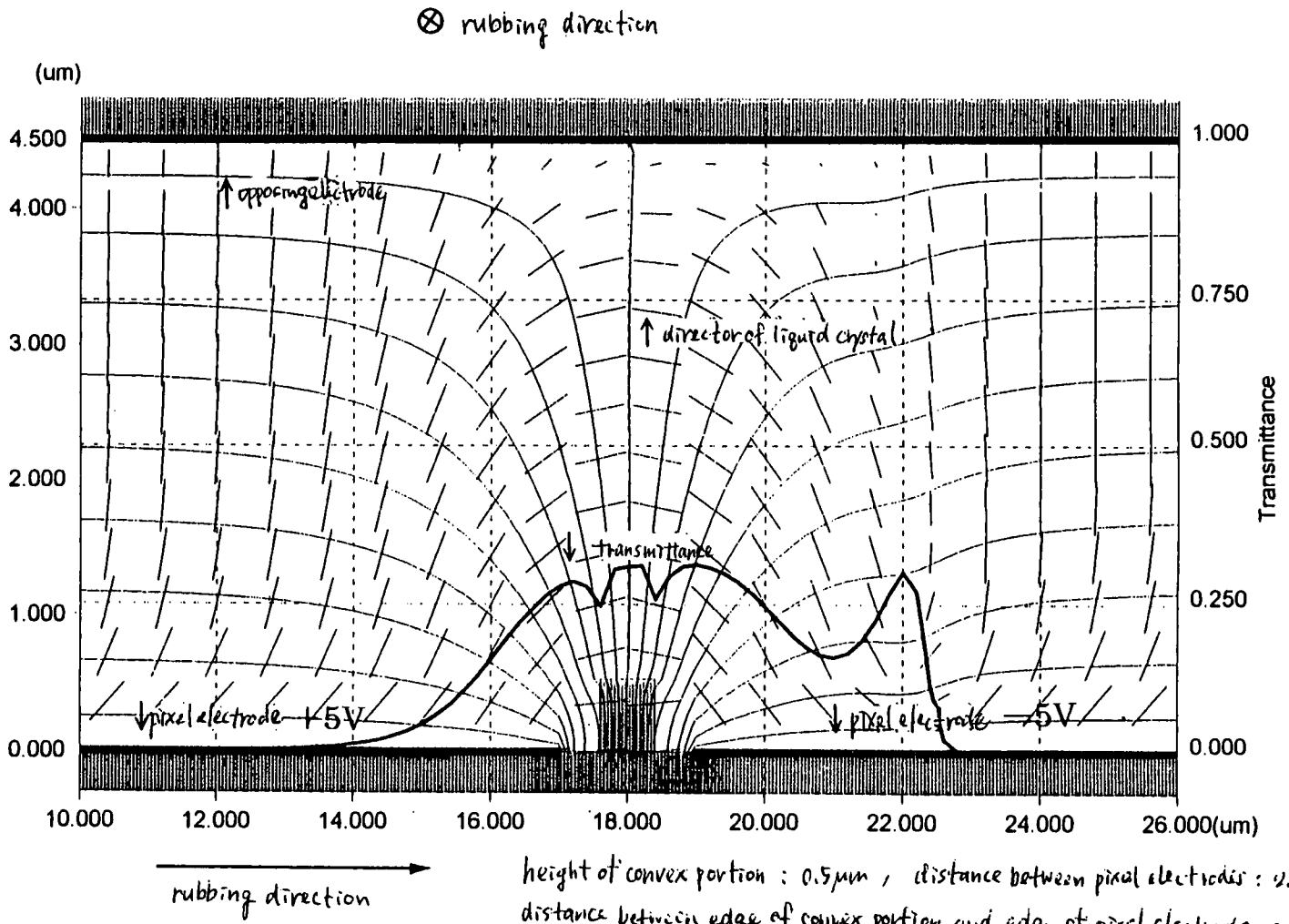

⊗ rubbing direction
(um)
4.500
4.000
3.000
2.000
1.000
0.000
1.000
0.750
0.500
0.250
0.000
Transmittance
↑ opposing electrode
↑ director of liquid crystal
↓ transmittance
↓ pixel electrode +5V
↓ pixel electrode −5V
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
26.000(um)
rubbing direction
height of convex portion : 0.5μm , distance between pixel electrodes : 2.0μm
distance between edge of convex portion and edge of pixel electrode : 0.5μm

Fig. 12

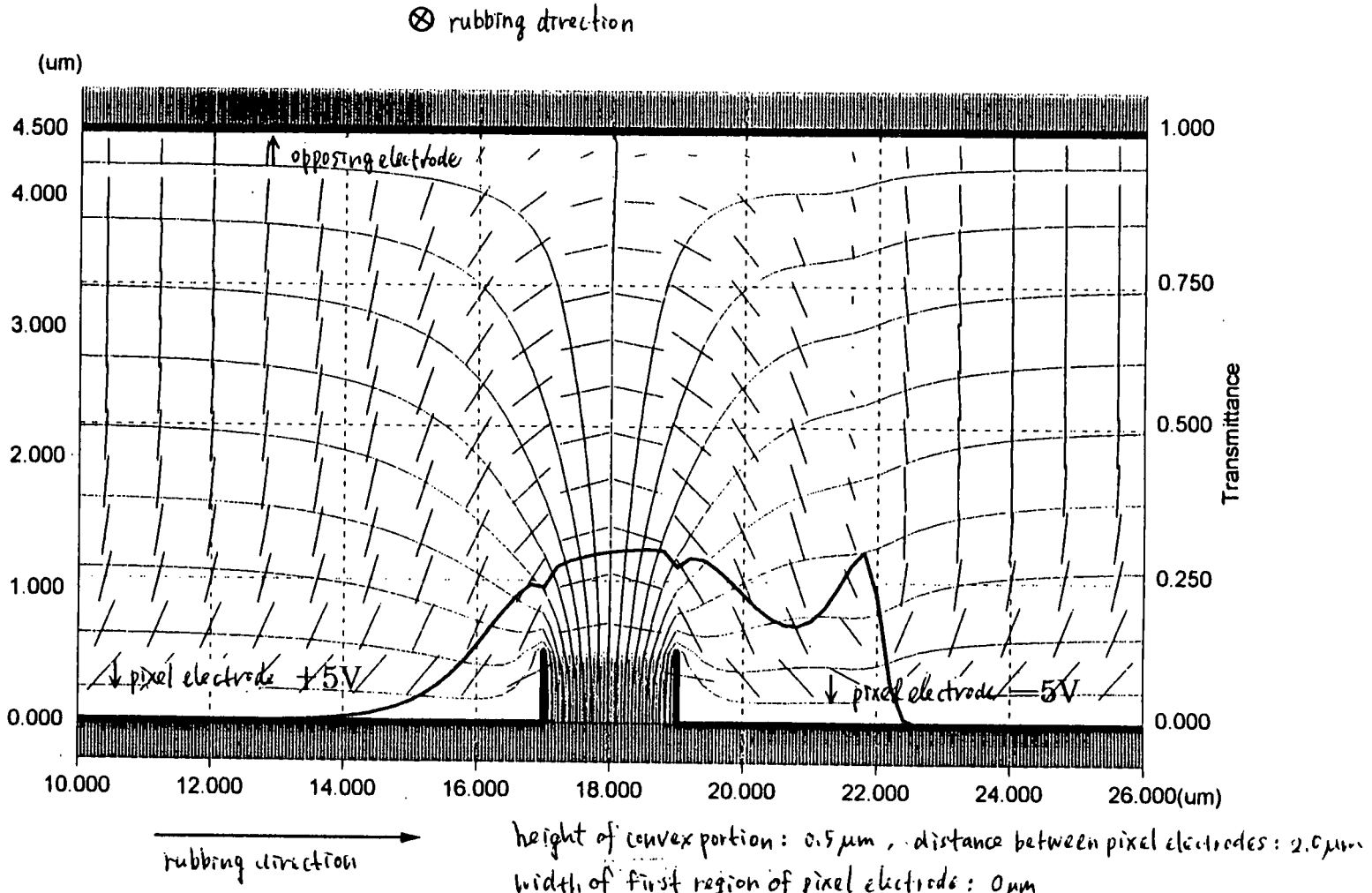

⊗ rubbing direction
(um)
4.500
4.000
3.000
2.000
1.000
0.000
opposing electrode
pixel electrode +5V
pixel electrode −5V
1.000
0.750
0.500
0.250
0.000
Transmittance
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
26.000(um)
rubbing direction
height of convex portion : 0.5μm , distance between pixel electrodes : 2.0μm
width of first region of pixel electrode : 0μm

Fig. 13

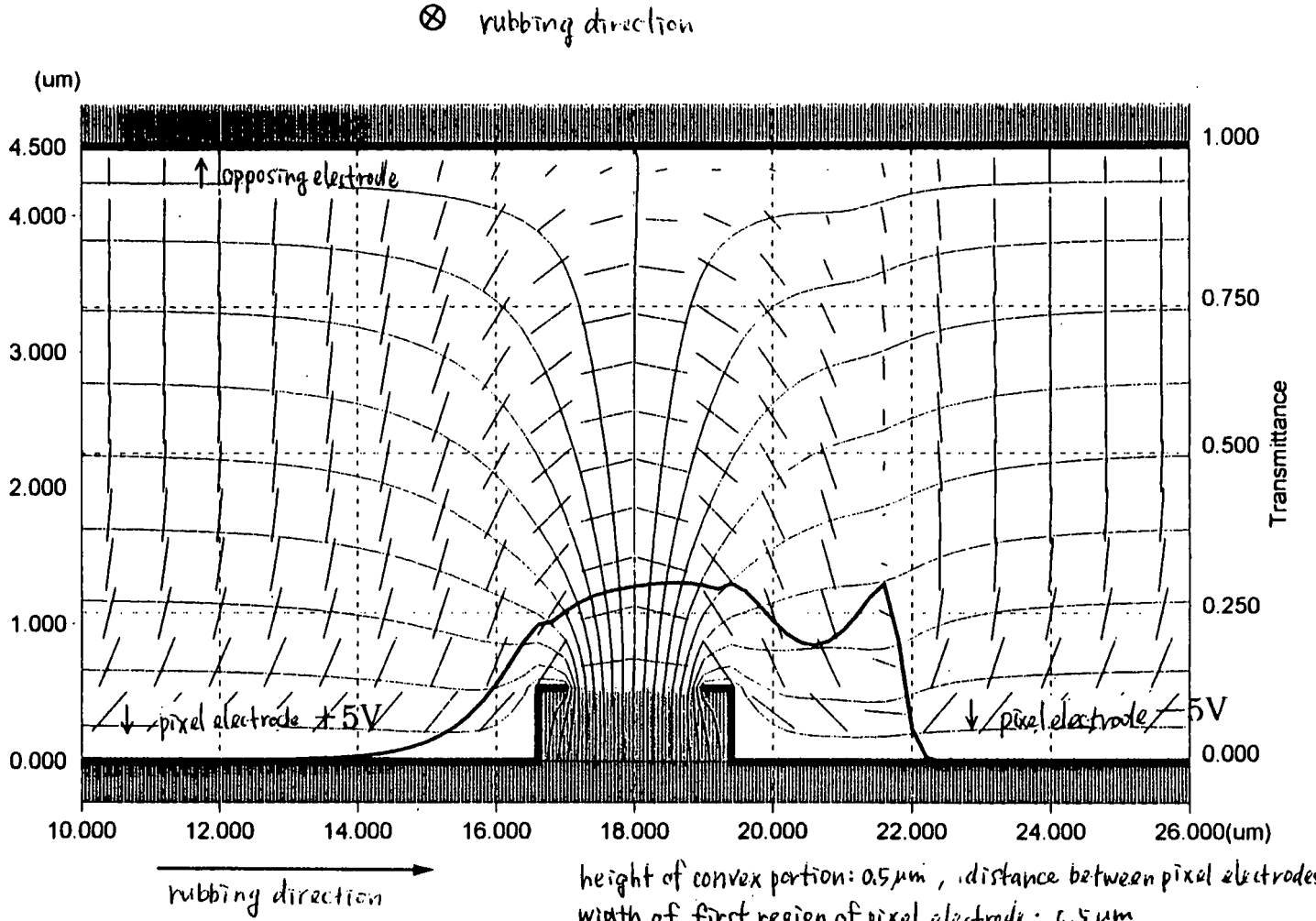

⊗ rubbing direction
(um)
4.500
4.000
3.000
2.000
1.000
0.000
↑ opposing electrode
↓ pixel electrode ±5V
↓ pixel electrode ∓5V
1.000
0.750
0.500
0.250
0.000
Transmittance
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
26.000(um)
rubbing direction
height of convex portion: 0.5μm , distance between pixel electrodes: 2.0 μm
width of first region of pixel electrode: 0.5μm

Fig. 14

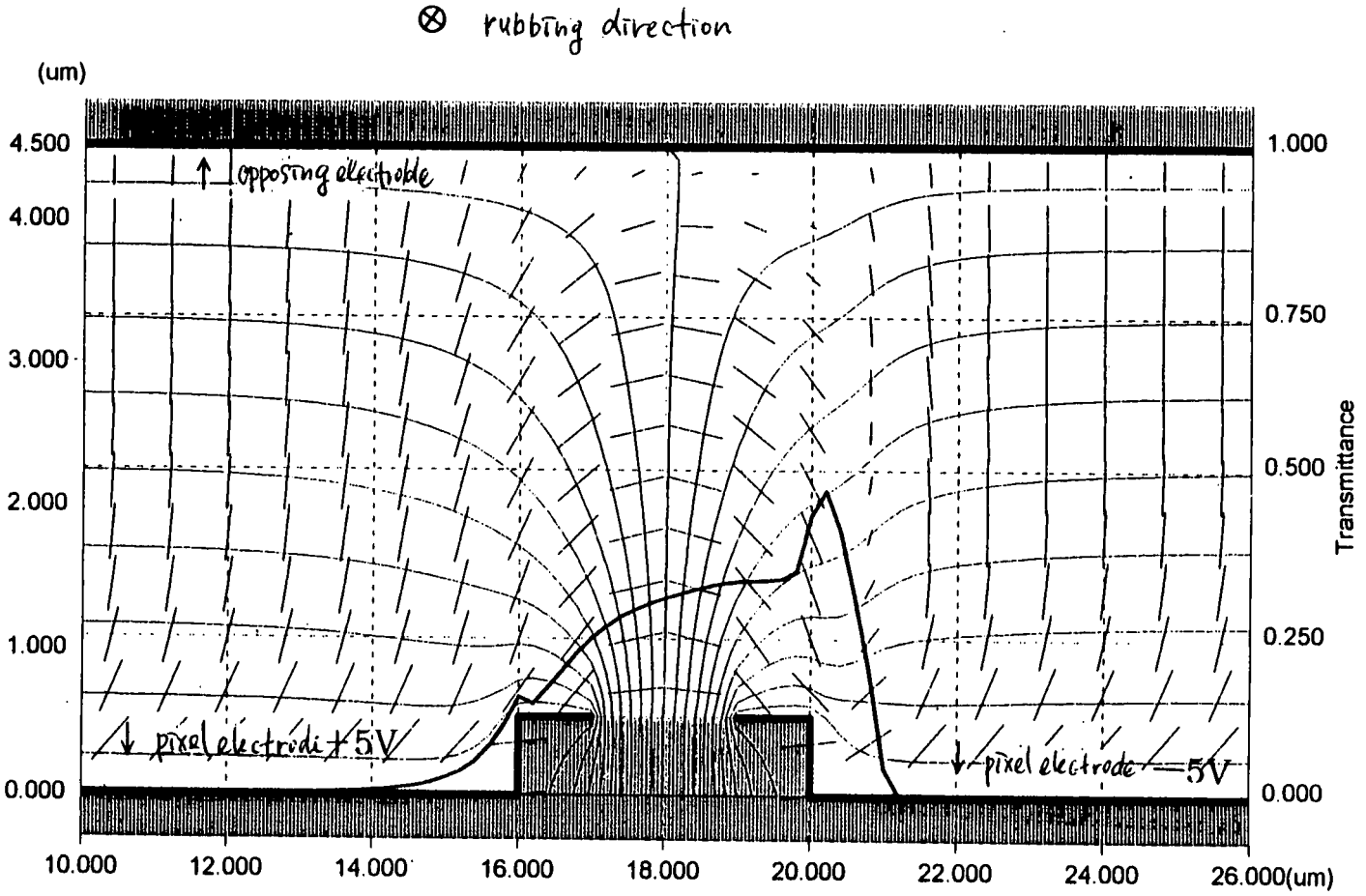

⊗ rubbing direction
(um)
4.500
4.000
3.000
2.000
1.000
0.000
opposing electrode
pixel electrode +5V
pixel electrode −5V
1.000
0.750
0.500
0.250
0.000
Transmittance
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
26.000(um)
rubbing direction
height of convex portion : 0.5μm , distance between pixel electrode : 2.0μm
width of first region of pixel electrode : 1.0μm

Fig. 15

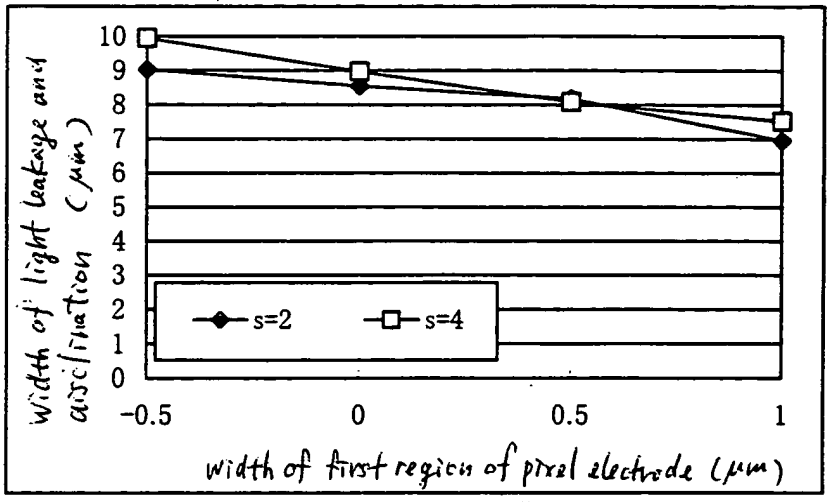


Fig. 16A

The relation between width of first region of pixel electrode and width of disclination and light leakage

distance between pixel electrodes : 2.0μm (s=2) / 4.0μm (s=4)

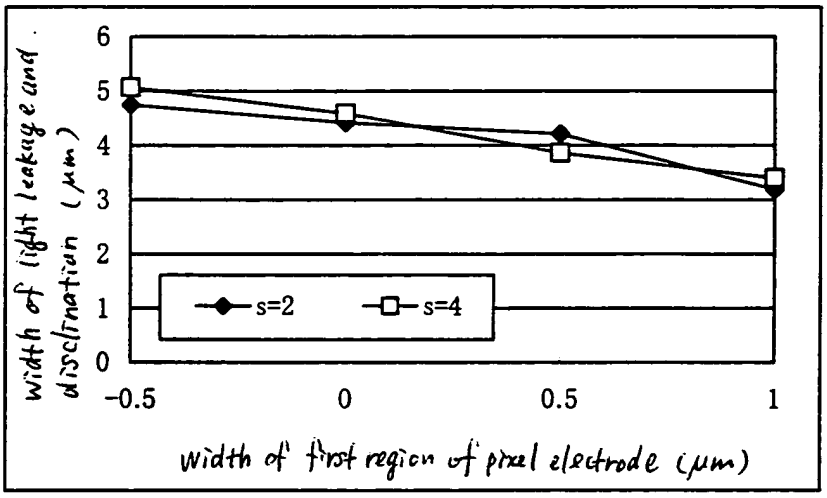


Fig. 16B

The relation between width of first region of pixel electrode and width of disclination and light leakage

distance between pixel electrodes : 2.0μm (s=2), 4.0μm (s=4)

Fig. 17

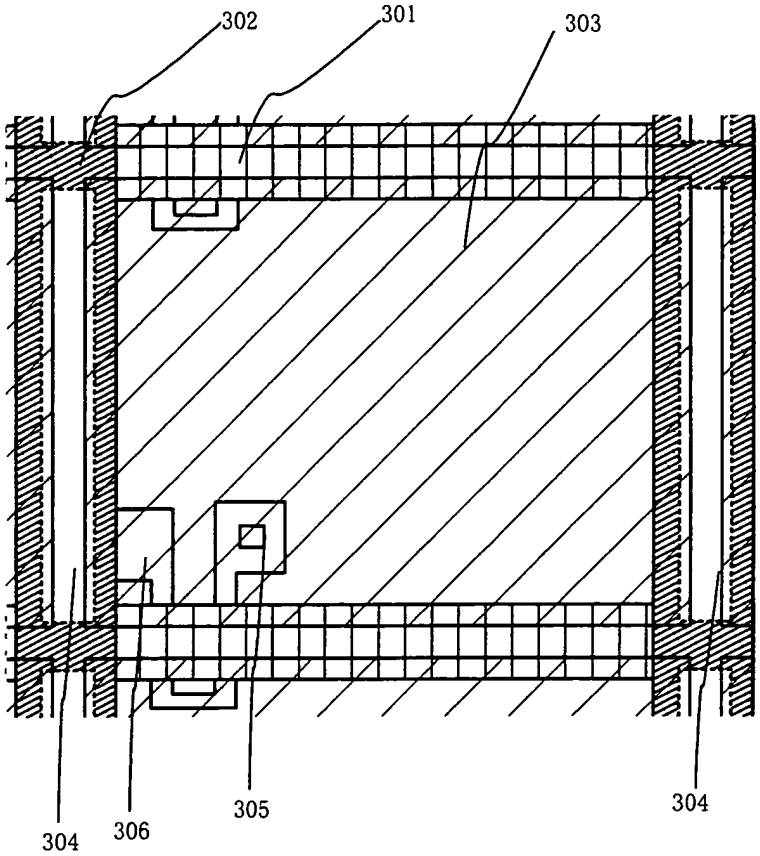


Fig. 18

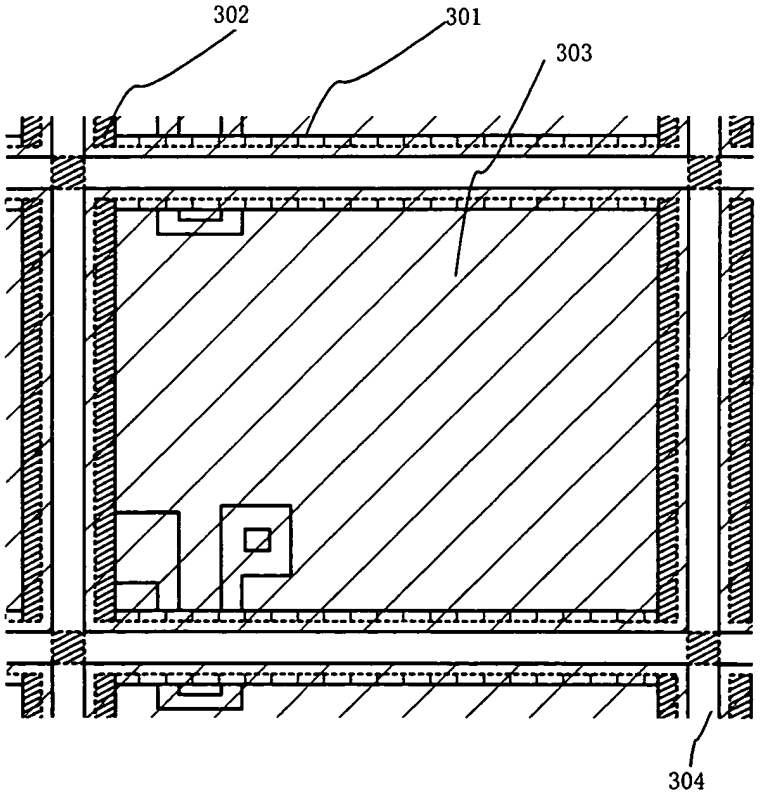


Fig. 19

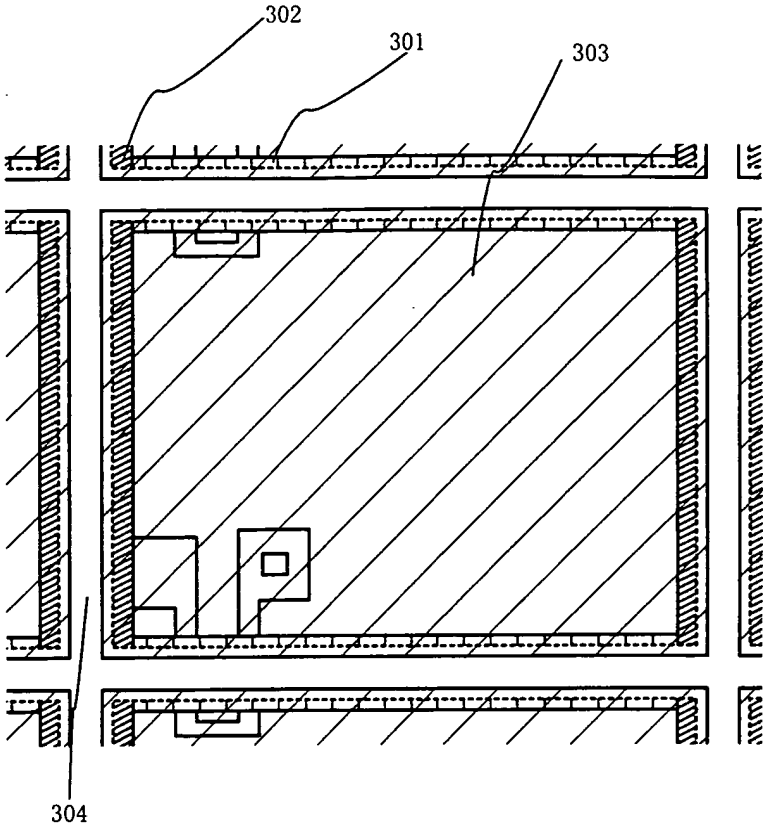


Fig. 20

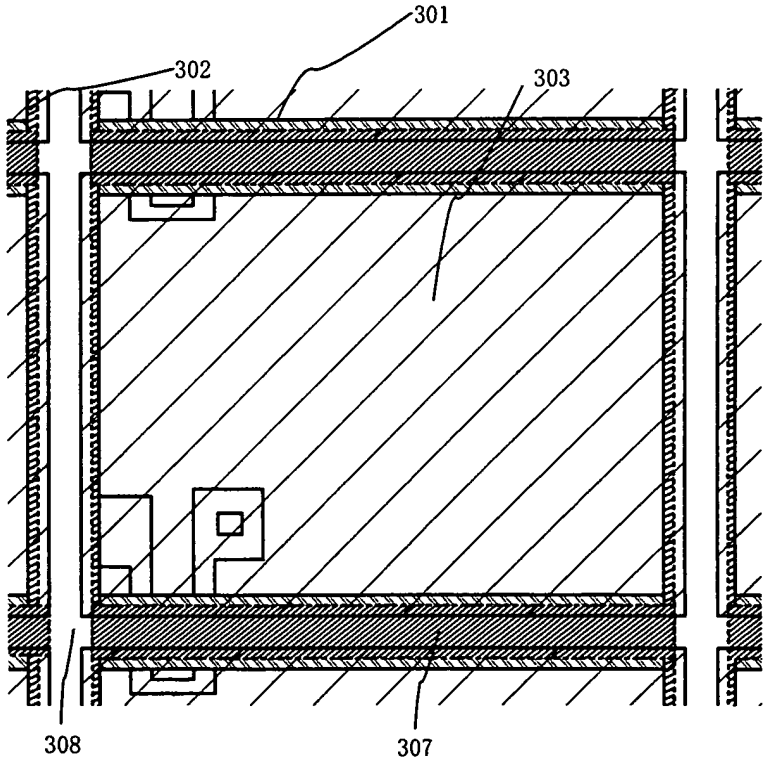


Fig. 21A

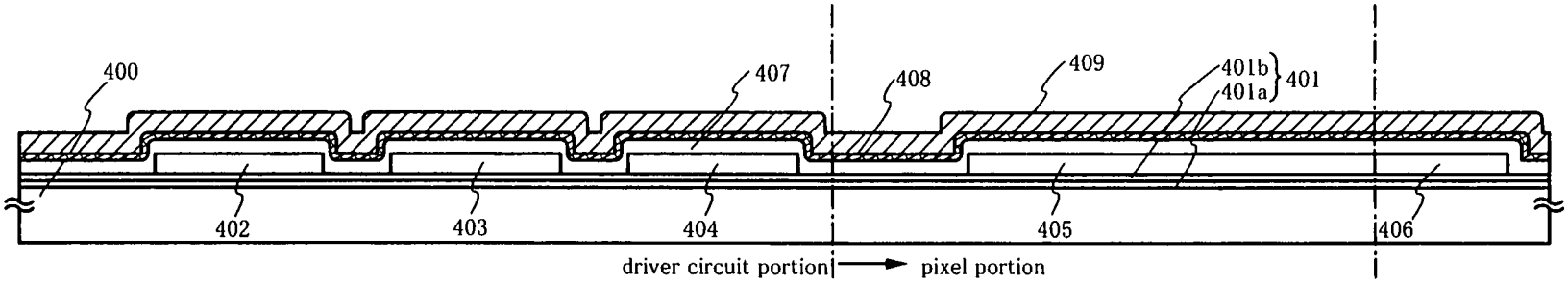


Fig. 21B

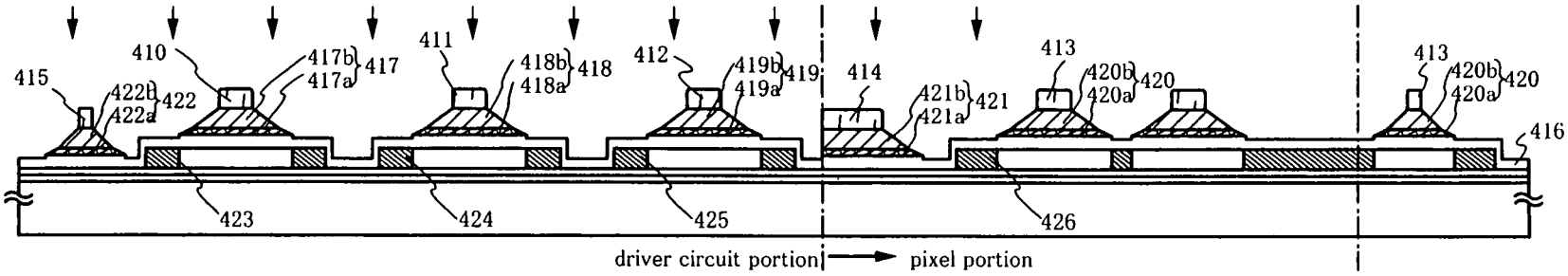


Fig. 21C

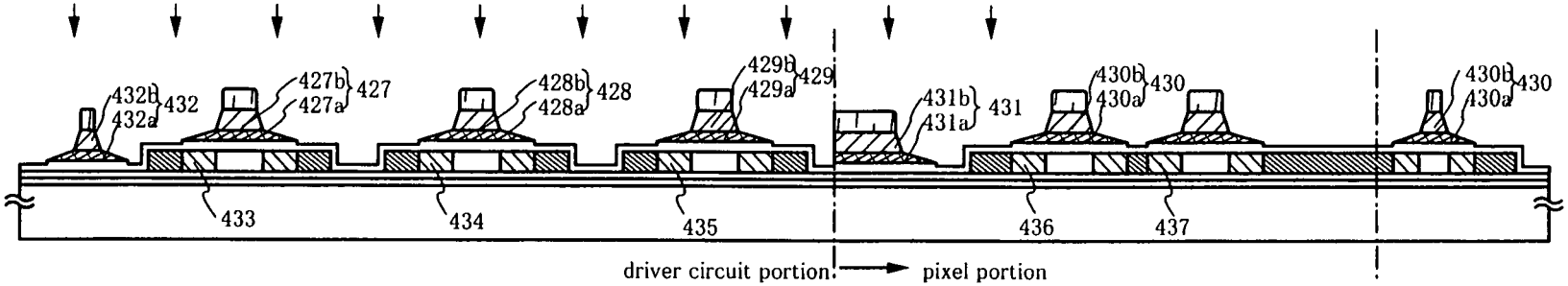


Fig. 22A

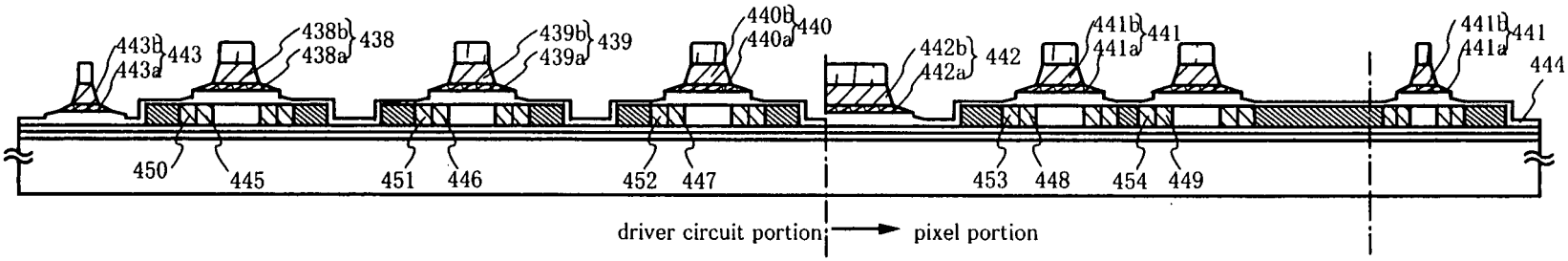


Fig. 22B

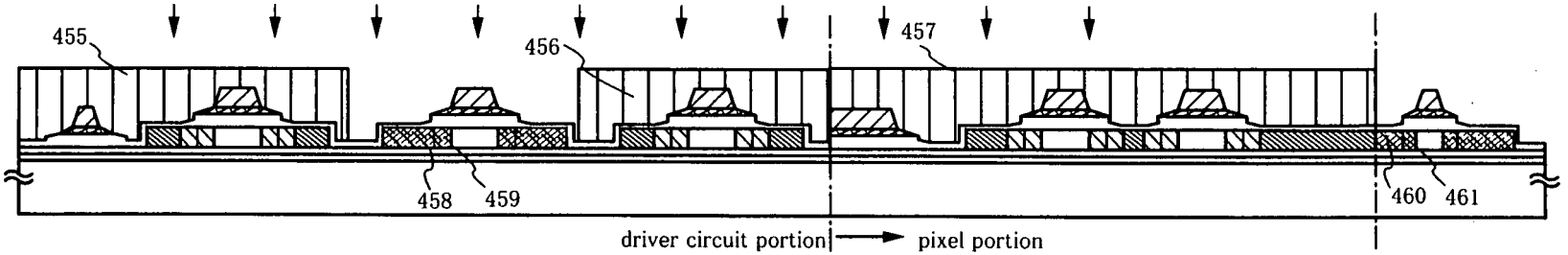
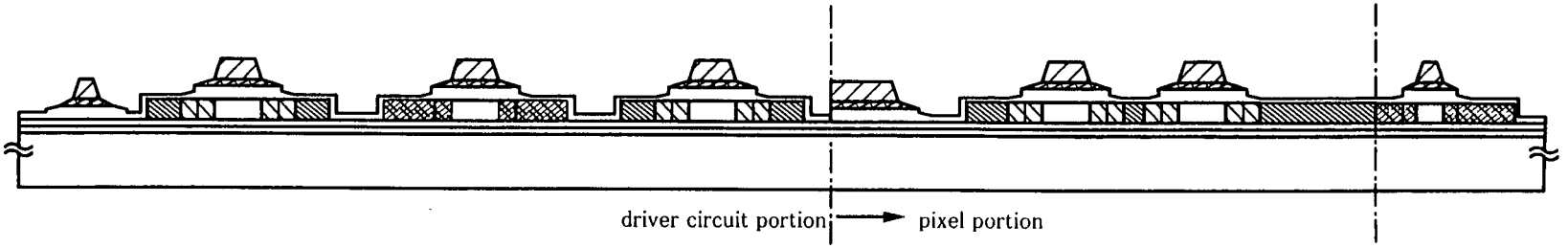
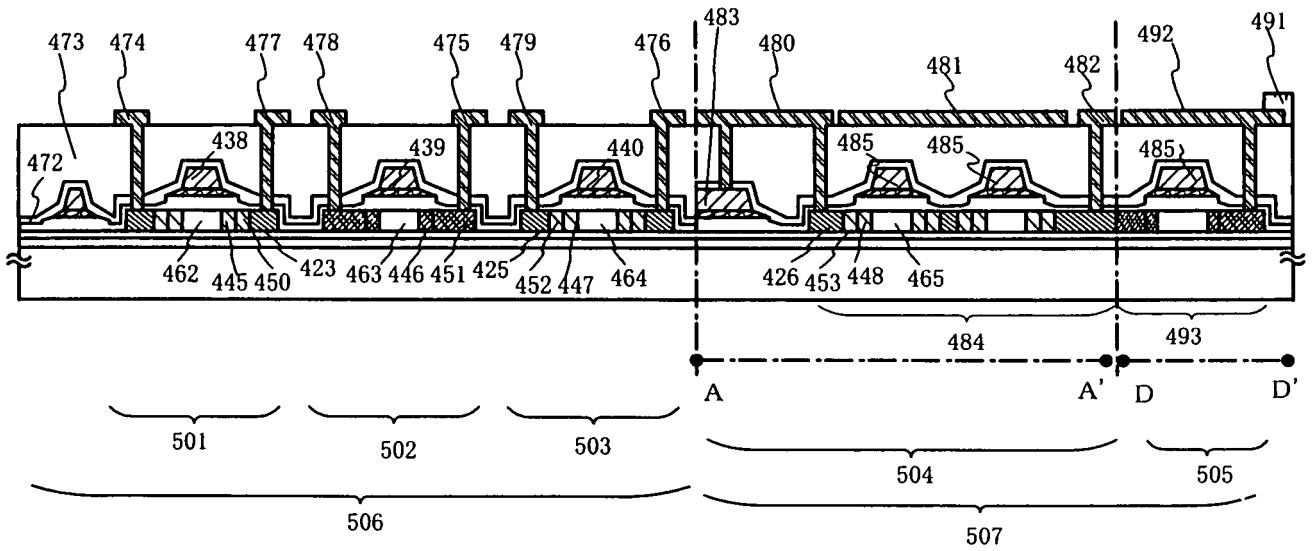


Fig. 22C

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462
445
450
423
463
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451
425
452
447
464
426
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448
465
484
493
A
A'
D
D'
501
502
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504
505
506
507

Fig. 23

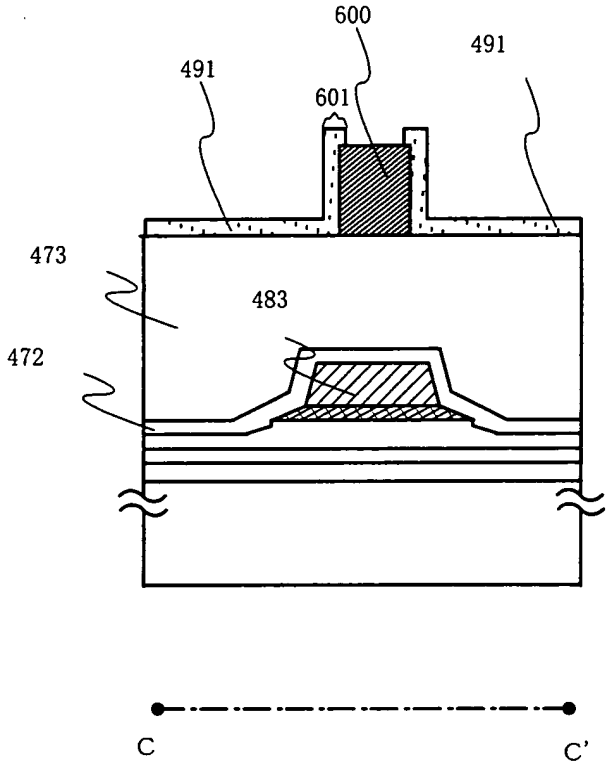

Fig. 24

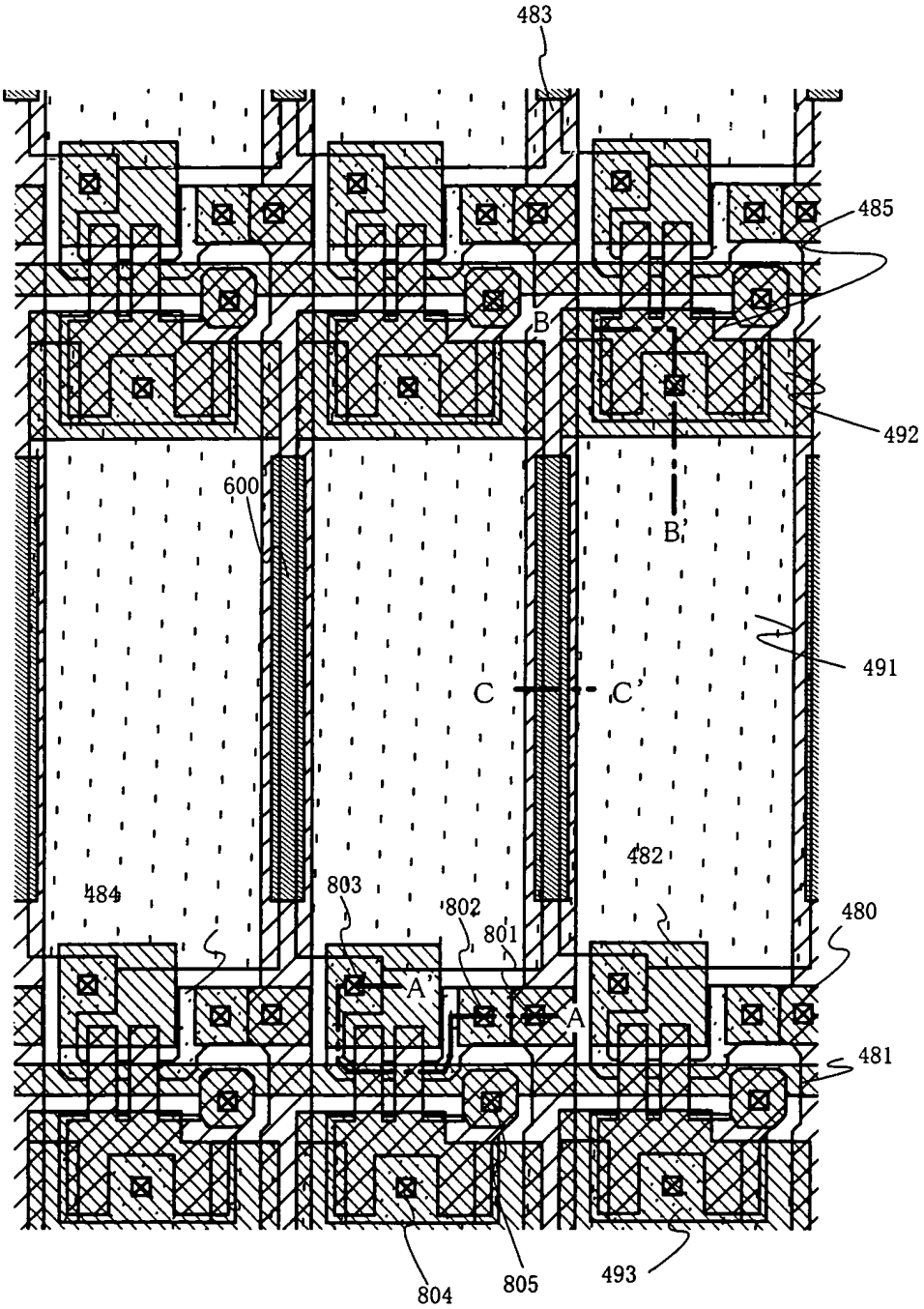
483
485
B
492
600
B'
491
C
C'
482
484
803
802
801
480
A'
A
481
804
805
493

Fig. 25

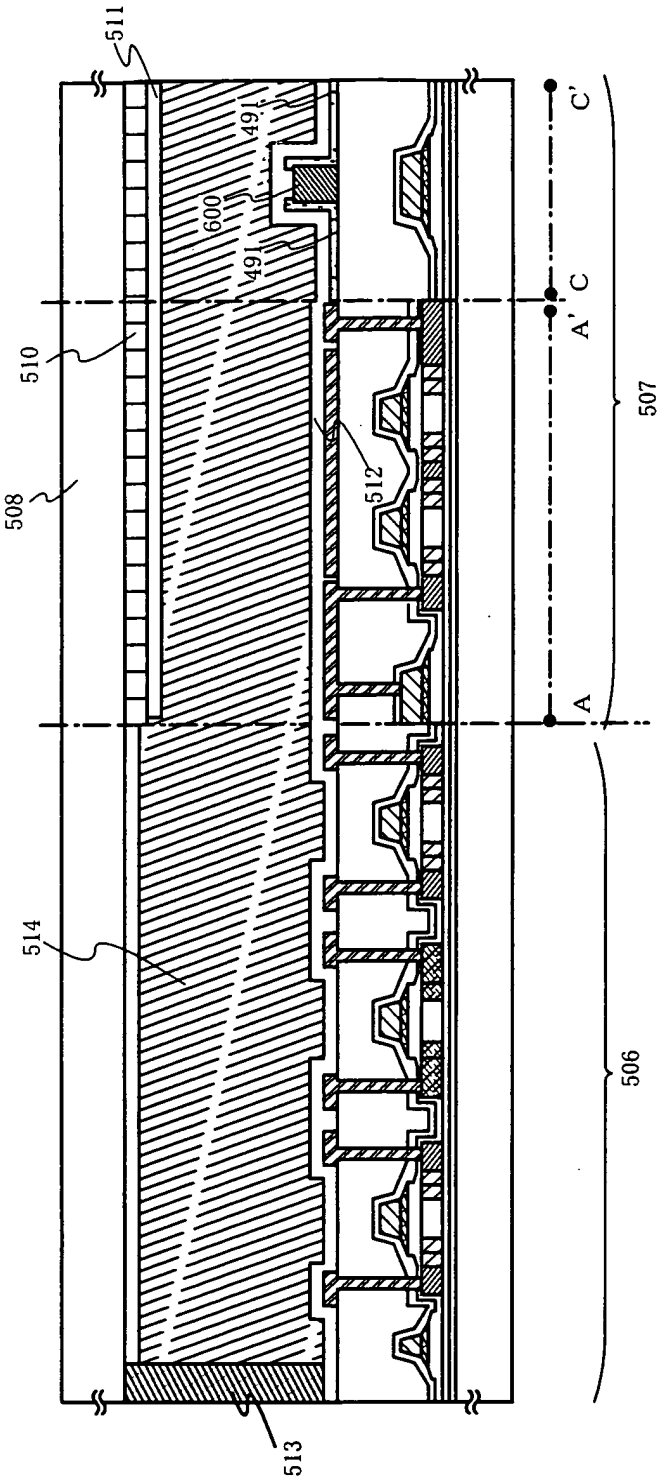

Fig. 26

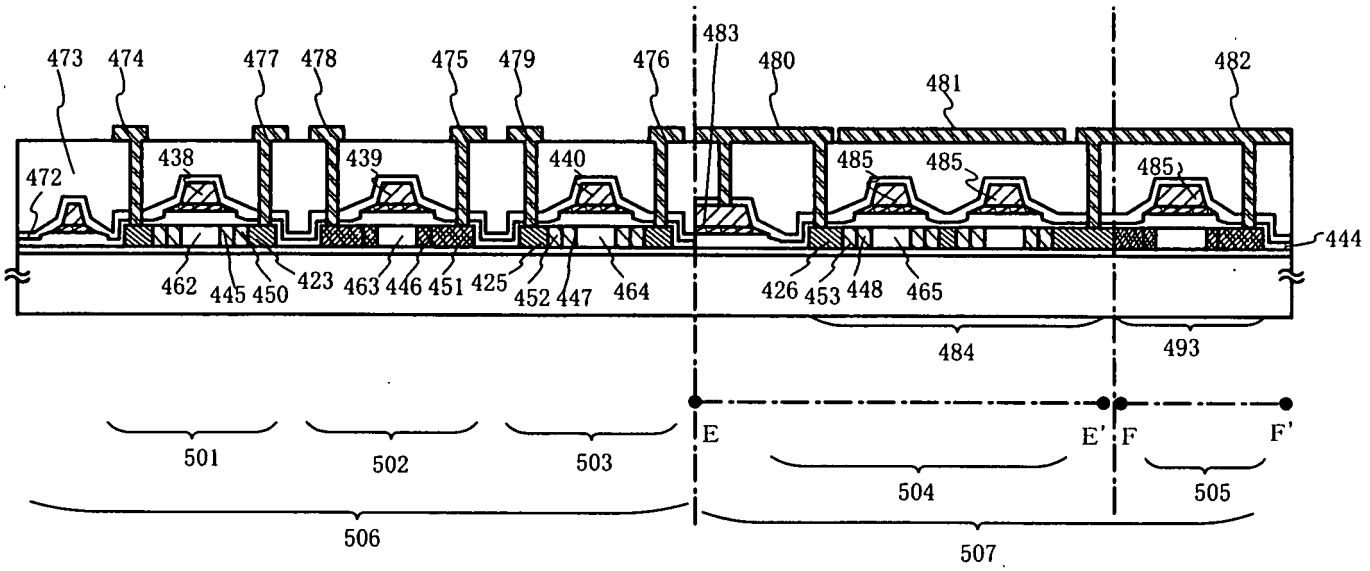
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Fig. 27

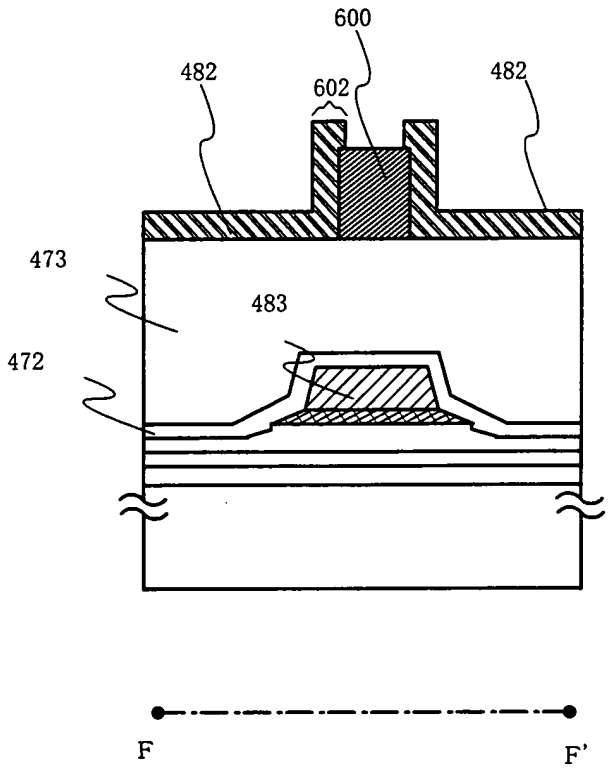


Fig. 28

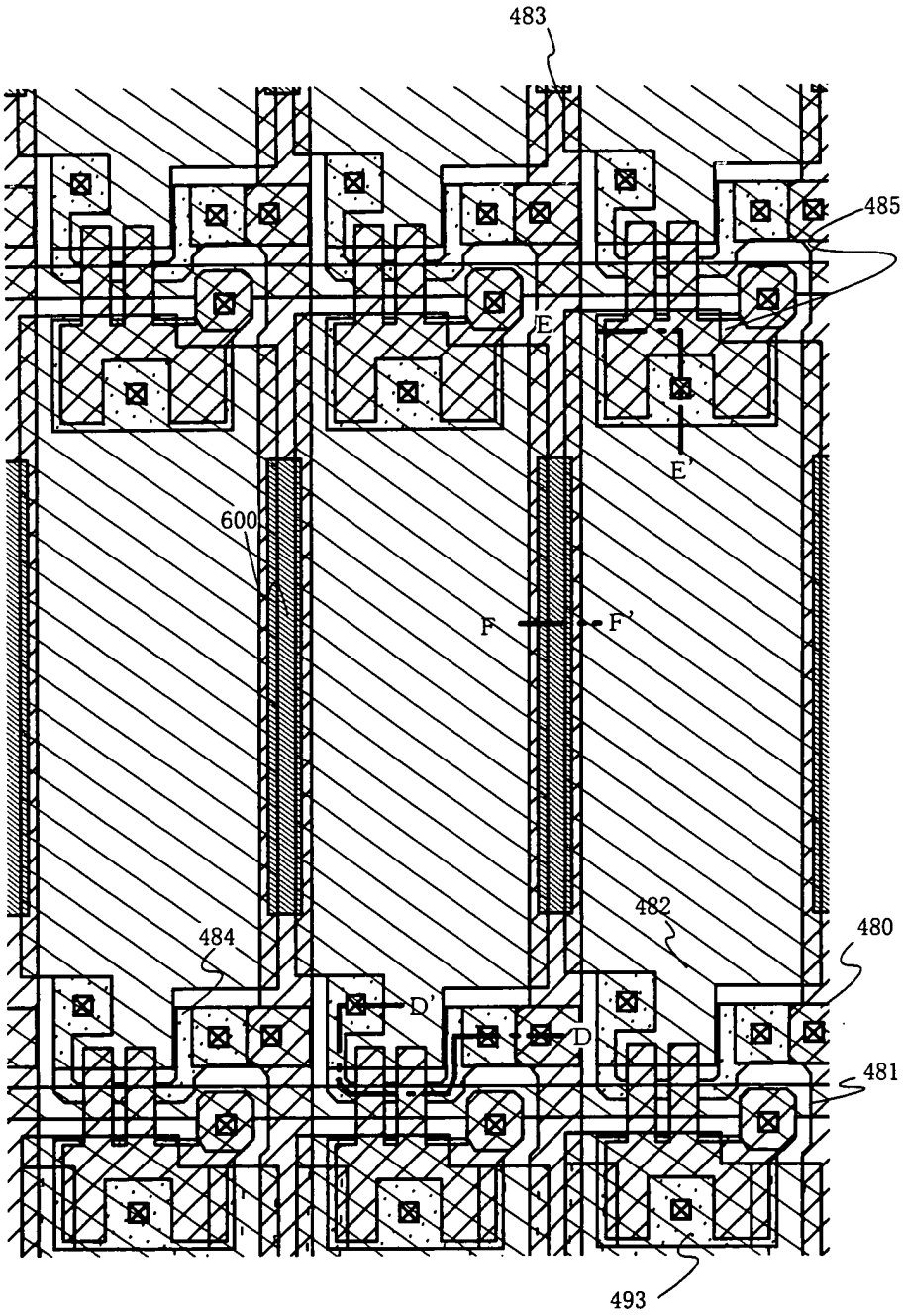


Fig. 29

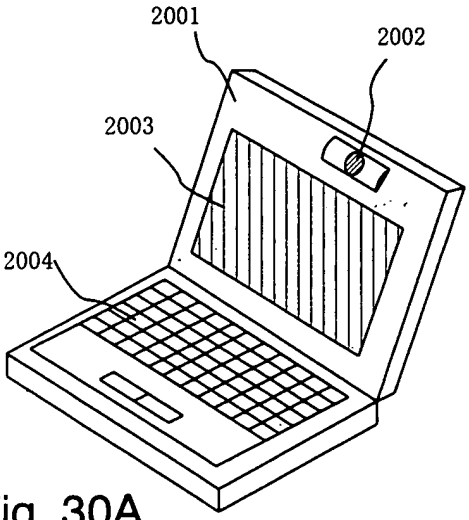


Fig. 30A

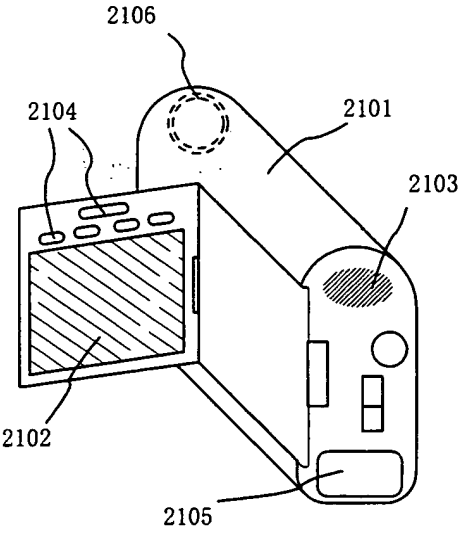


Fig. 30B

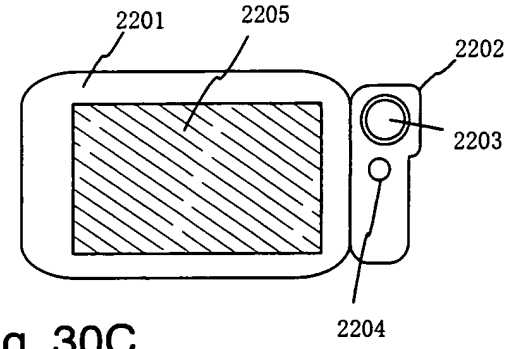


Fig. 30C

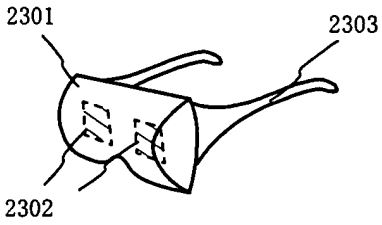


Fig. 30D

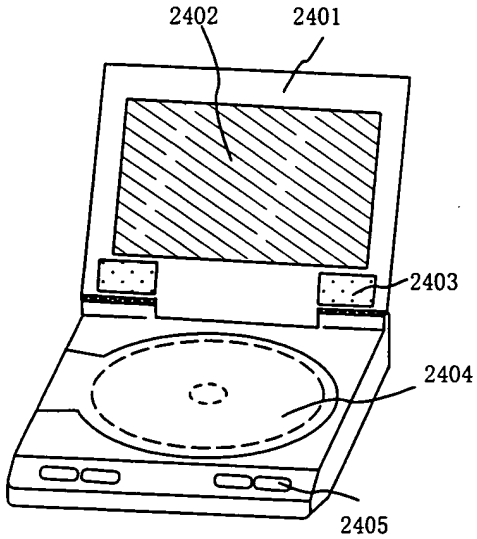


Fig. 30E

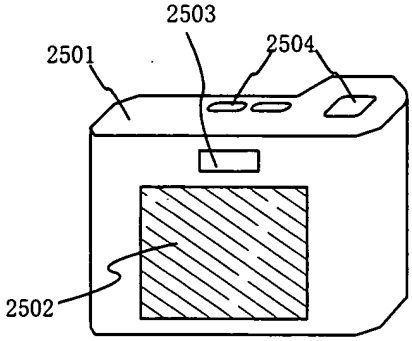


Fig. 30F

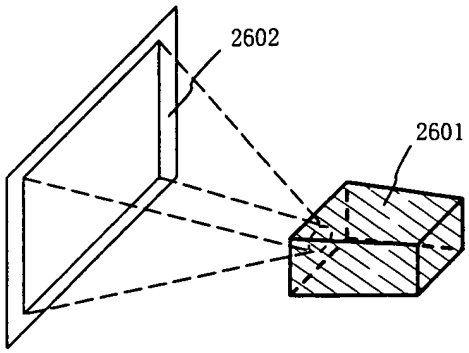


Fig. 31A

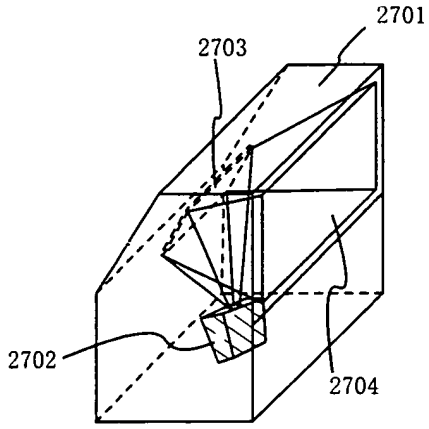


Fig. 31B

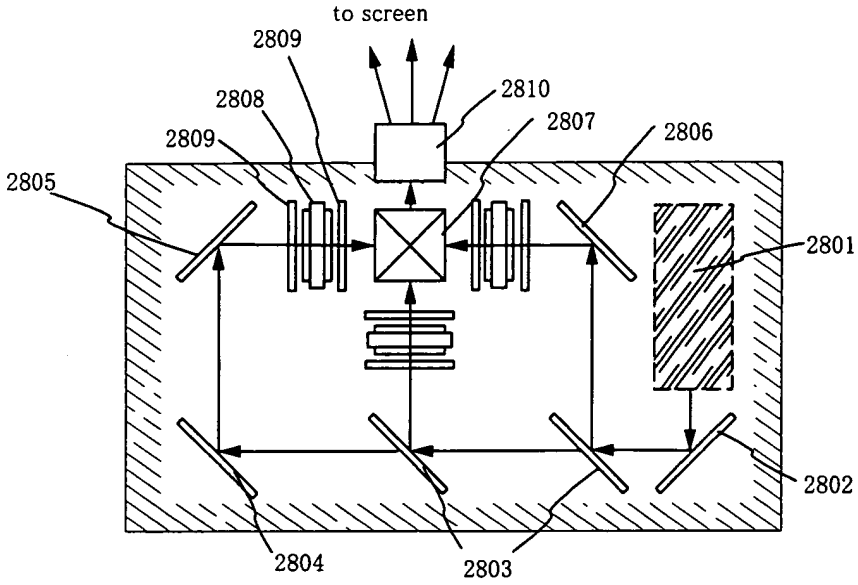


Fig. 31C

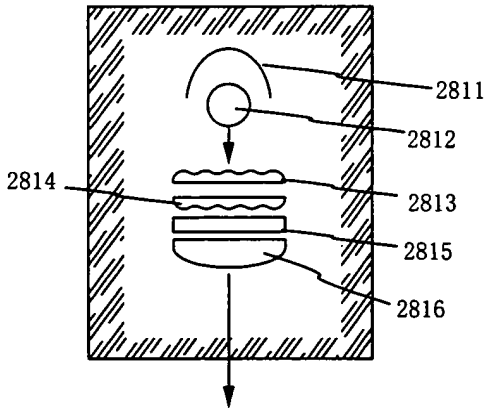


Fig. 31D

Fig. 32A

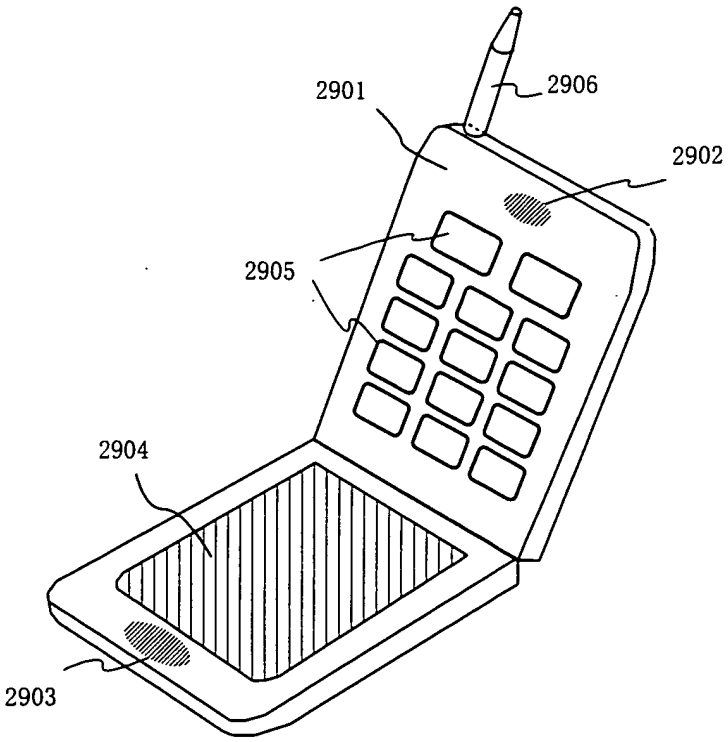


Fig. 32B

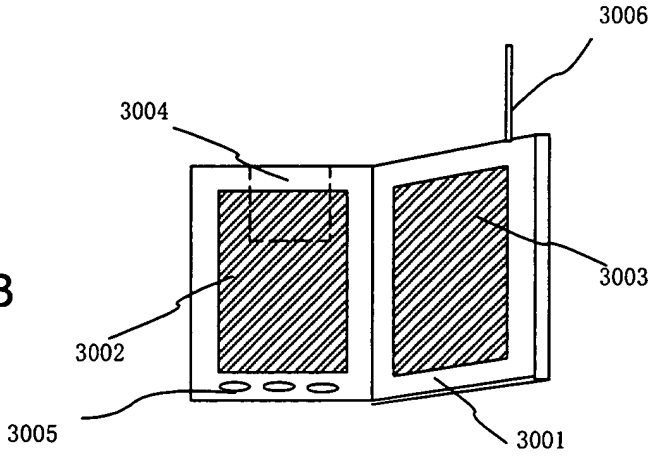


Fig. 32C

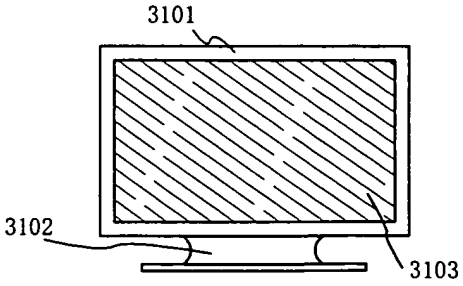


Fig. 33A

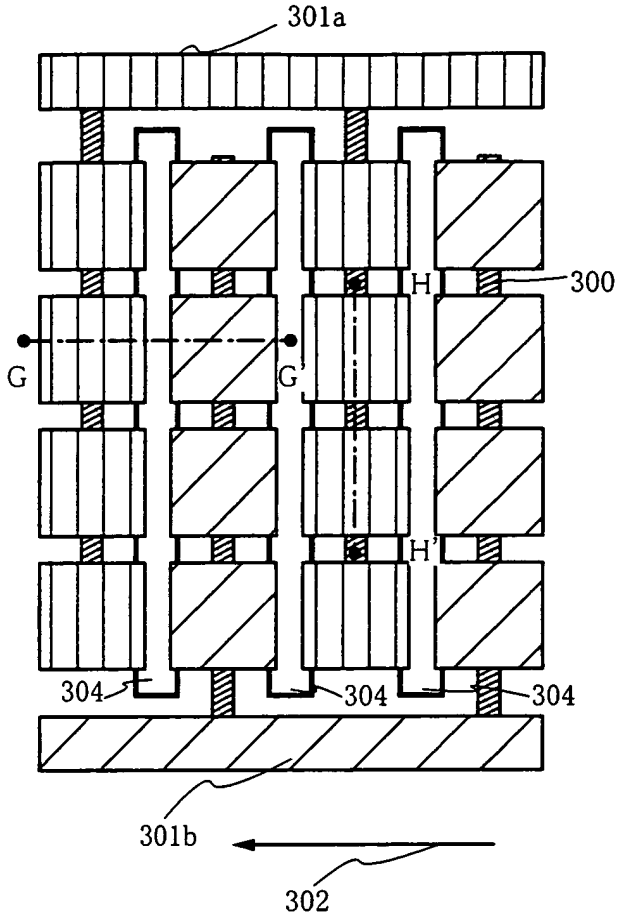


Fig. 33B

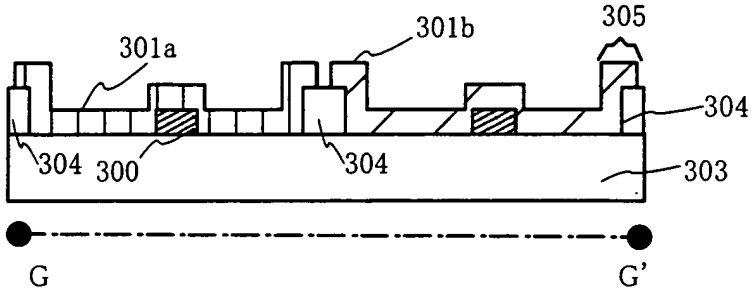
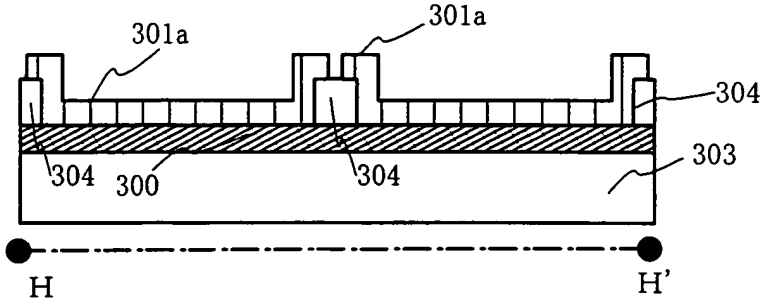
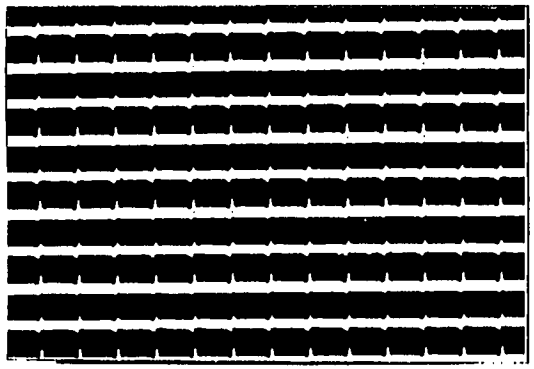


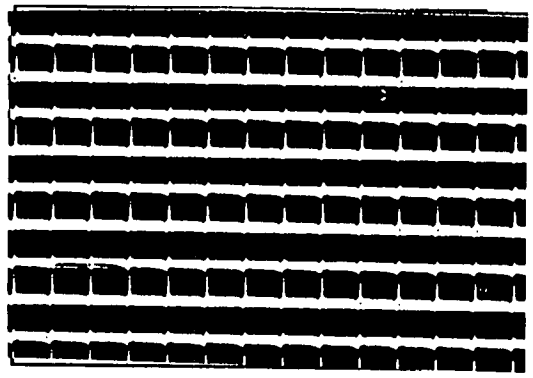
Fig. 33C





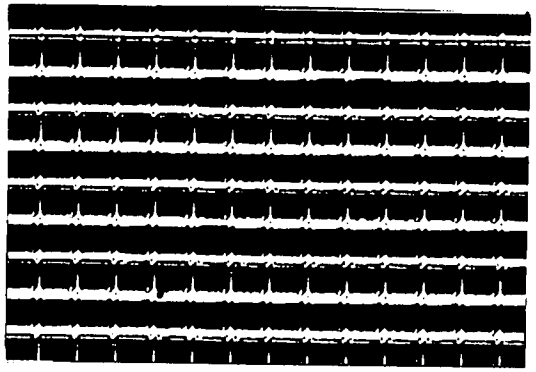
o=−1.0μm

Fig. 34A



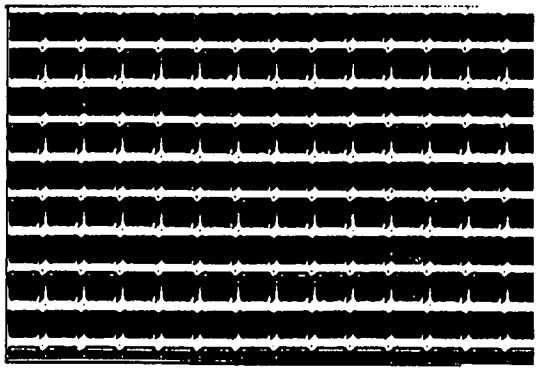
o=0μm

Fig. 34B



o=0.5μm

Fig. 34C



o=1.0μm

Fig. 34D

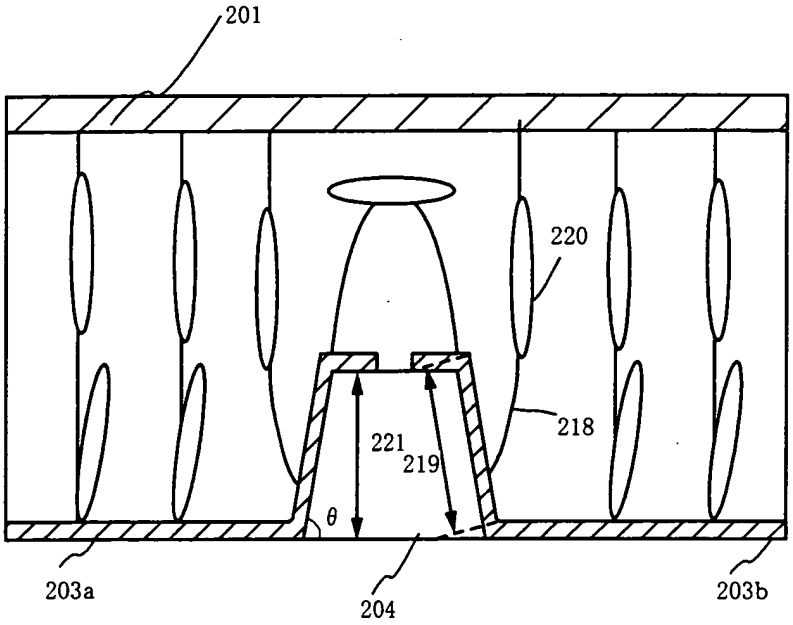
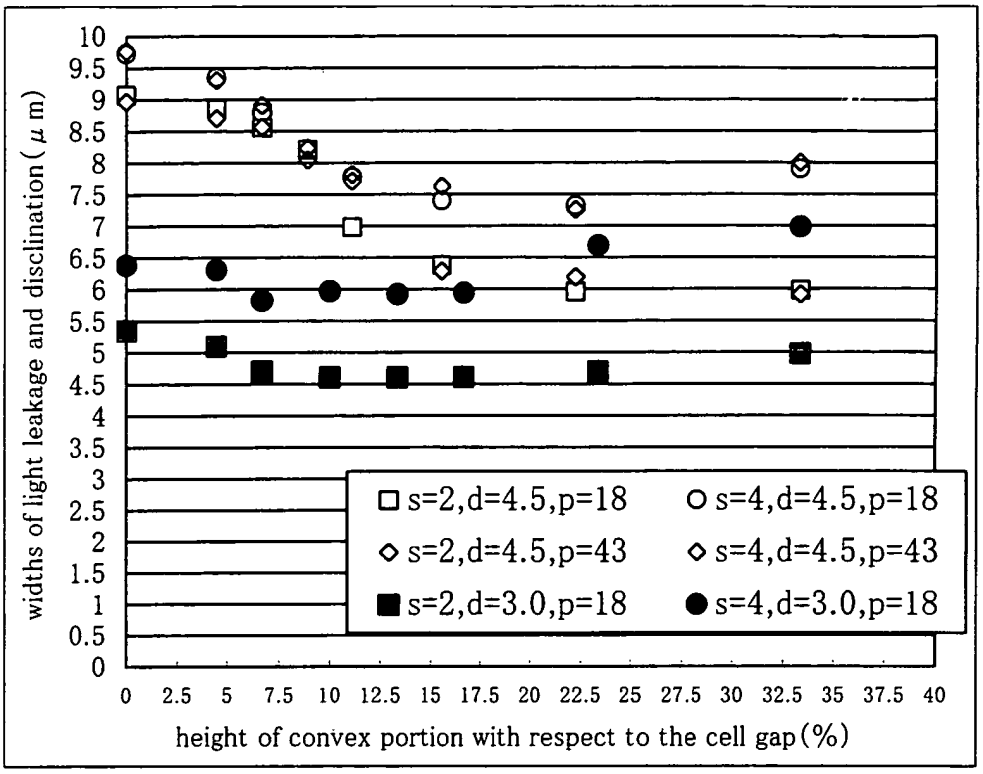


Fig. 35

Fig. 36



d: cell gap (μ m)
s: distance between pixel electrodes (μ m)
p: pixel pitch (μ m)

relationship between widths of light leakage and disclination (x) and height of convex portion (h)

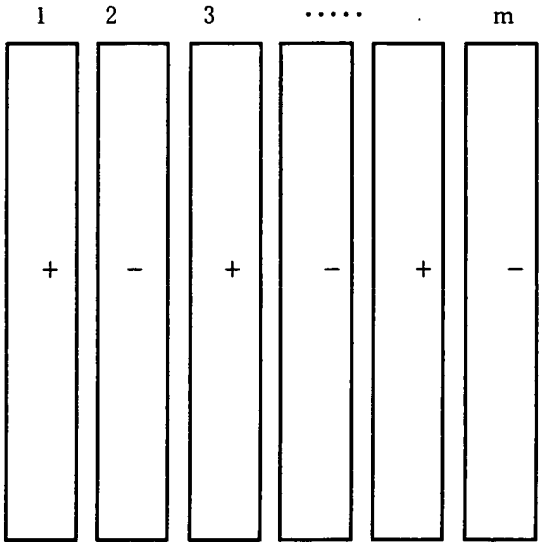


Fig. 37A

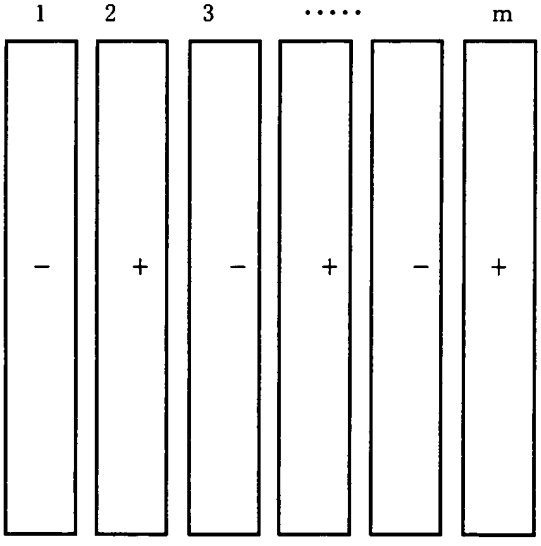


Fig. 37B